Flood Risk Assessment and Risk Reduction Plan

Prepared for:
Charlotte-Mecklenburg Storm Water Services

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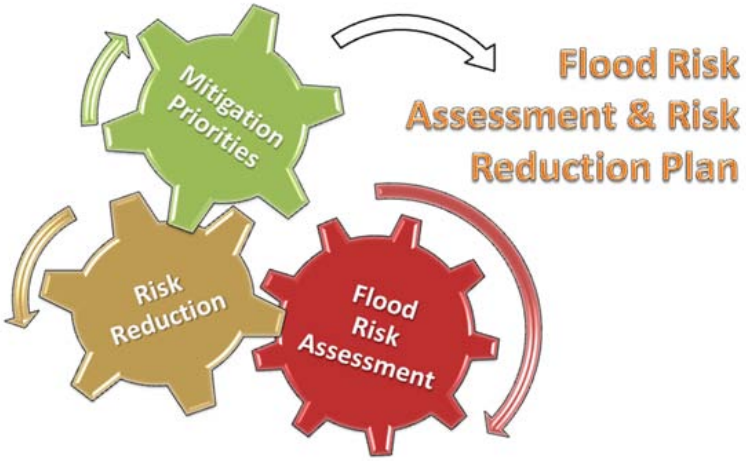
Executive Summary

Charlotte-Mecklenburg Storm Water Services (CMSWS) manages and maintains the regulated floodplains within the City of Charlotte, the towns of Cornelius, Davidson, Huntersville, Matthews, Mint Hill, and Pineville, and the unincorporated areas of Mecklenburg County.

CMSWS aims to serve the citizens of Mecklenburg County by reducing the potential for loss of life and property due to flooding, while enhancing the natural and beneficial functions of the floodplain along streams regulated by the Federal Emergency Management Agency (FEMA). There are over 4,000 structures in approximately 350 miles of regulated streams within the County. The CMSWS Flood Mitigation Program is responsible for assessing flood risk, developing mitigation plans, and identifying flood hazard mitigation projects within the floodplain.

As a national leader in local floodplain management, CMSWS has historically integrated risk identification, assessment, and planning. These efforts have resulted in the successful implementation of structural and non-structural risk reduction measures, including the acquisition and demolition of more than 250 flood-prone structures within the County as well as the adoption of local floodplain development regulations that exceed Federal standards. This ***Flood Risk Assessment and Risk Reduction Plan*** (Flood RA/RR Plan) is designed to assist the County's Flood Mitigation Program in building and expanding upon these previous efforts to minimize the consequences to people and property when a flood occurs.

The approaches, methods, and products described in this plan are necessary to further integrate the County's risk identification, assessment, and planning efforts. CMSWS expects to leverage detailed local data and new mapping products with technology in order to perform property-specific risk assessments, identify planning-level mitigation projects, and set project priorities. It will allow CMSWS to engage in risk-based mitigation planning and decision making, resulting in strategic, sustainable actions that reduce or eliminate risks to life and property from flooding. This project also represents a significant step forward in increasing the public's awareness and understanding of risk management.



The Flood RA/RR Plan is designed to be a dynamic, continuously updated plan that will aid in identifying, prioritizing, and planning future flood mitigation projects. It will be a "digital plan" and as such will be routinely updated as new data becomes available. Examples of data that can change over time include property specific data such as Elevation Certificates, parcel information, and building footprints, as well as hazard-

specific data such as flood hazard maps and velocity areas, and also environmental data, such as water quality buffers, environmental focus areas, etc.

The plan includes three main elements which link Flood Risk Property Scores at the individual property (parcel) level with Risk Reduction Recommendations that are then supported by Flood Mitigation Priority Scores. Each element builds upon the previous element to produce the results that will be stored in the plan data as described below:

- ***Flood Risk Property Score***—consists of analyzing factors related to flood impacts, storm frequency, and structure location on an individual property basis.
- ***Risk Reduction Recommendations***—consists of evaluating 19 different flood mitigation techniques deemed most appropriate for Mecklenburg County and making a planning-level recommendation of either 1) Highly Effective, Recommended, 2) Effective, 3) Further Evaluation Needed, 4) Not Recommended.
- ***Flood Mitigation Priority Scores***—consists of assessing and accounting for community benefits and other factors based on Risk Reduction Recommendations that are not accounted for in the Flood Risk Property Score. The Flood Mitigation Priority Score is used to prioritize individual properties as well as project areas (i.e., groups, or "clusters" of properties) for mitigation activities.

The ***Flood Risk Property Score*** is intended to be a relative indicator of a property's flood risk. Flood risk is defined as the likelihood of an event occurring (probability) multiplied by the impacts/consequences (financial, personal, and property damage) that occur. The Flood Risk Scoring System generates a specific Flood Risk Property Score for individual properties. The Flood Risk Property Score is derived through the identification of the potential flood impacts (consequences, or damages) to the property, quantifying the likelihood that the flood impact will occur, and accounting for additional risks to the structure due to location. The flood impact factors deemed important to citizens within the Mecklenburg County floodplain and incorporated into the Flood Risk Property Score are:

- Finished floor/living space
- Frequency of flooding
- Location within the floodplain (including velocity)
- Crawl space
- Mechanical/systems
- Vehicles
- Ingress/egress from the building and property during a flood
- Exterior improvements (detached garages, sheds, pools, etc.)
- Number of dwelling units impacted

The end result of applying the Flood Risk Scoring System is a numerical score that provides information about the relative flood risk for the property. CMSWS can use this score to aid in prioritizing the flood-prone properties according to their flood risk for flood mitigation planning purposes. The intent of this step is to identify the properties at risk, and to quantify their actual level of risk based on available flood hazard data and building information for each property.

The ***Risk Reduction Recommendations*** contained within the plan data are intended to be used to guide both public and private flood mitigation activities. The plan will identify flood mitigation techniques that would be most effective in reducing flood risk for each property. The key to any flood hazard mitigation plan is *implementing actions* that will eliminate or reduce flood risk. Therefore, mitigation recommendations will be made for each flood-prone property based on the evaluation of different mitigation techniques according to a variety of selection criteria. As part of the plan, the following 19 mitigation techniques have been identified and determined to be appropriate for application in Mecklenburg County:

1. Property Acquisition and Structure Demolition
2. Structure Demolition and Rebuild
3. Property Acquisition and Structure Relocation
4. Property Acquisition, Demolition or Relocation, and Re-sale
5. Structure Elevation
6. Abandon Basement and Fill
7. Dry Floodproofing of Structures
8. Wet Floodproofing of Structures
9. Audible Flood Warning System for Individual Property
10. Storm Water Detention Facilities
11. Storm Water System Control
12. Automated Flood Notifications
13. Public Education
14. Flood Insurance
15. Levee/Floodwall Protection for Multiple Structures
16. Protecting Service Equipment
17. Partial Dry Floodproofing
18. Partial Wet Floodproofing
19. Levee/Wall/Berm for a Single Structure

Mitigation recommendations will be made for each flood-prone property in the county. Each mitigation technique will be evaluated and placed into one of the following four categories for each property:

- ***Highly Effective, Recommended***—the mitigation technique is determined to be highly effective at reducing flood risk and in providing an additional community benefit.

- ***Effective***—the mitigation technique is determined to be feasible and effective for reducing flood risk.

- ***Further Evaluation Needed***—the minimum criteria for the mitigation technique are met but further evaluation or additional data is needed to determine if the technique is a viable option.

- ***Not Recommended***—the minimum criteria for the mitigation technique are not met. Therefore the technique is likely not feasible, effective, or may be cost prohibitive.

Flood Mitigation Priority Scores will be used to prioritize flood mitigation efforts across the county. The purpose of developing Flood Mitigation Priority Scores is to account for: (1) other community-based benefits and, (2) other factors not included in the Flood Risk Property Score. The factors incorporated into the Flood Mitigation Priority Scores are:

- Life and human safety
- Cost effectiveness
- Proximity to other mitigation projects
- Property added to flood zone
- Repetitive Loss (RL) structure
- Property adjacent to publicly owned land
- Property located on five-year planned greenway trail
- Property located on five-year planned sanitary sewer route
- Property intersects with water quality buffer
- Property located in an Environmental Focus Area
- Property covered by NFIP policy
- Historic preservation and cultural asset protection
- Other

CMSWS wants to prioritize future projects that could include individual properties as well as multiple properties grouped into one mitigation project. The same priority factors are used to generate both a Property Score and a Project Score. These scores will be used to prioritize properties and project areas for the County's mitigation planning purposes.

The ***planning process*** was a multi-year effort developed in two phases. Phase I focused on developing a framework for the approach and Phase II focused on refining, finalizing, and applying the approach. Prior to finalizing this plan, two floodplain areas were identified as part of a pilot study and used to test, demonstrate, and refine the scoring methodologies developed for the three steps. The pilot study included a mix of residential and commercial structures, and a variety of individual building types within each category. The results of the pilot study were used to identify potential issues, such as data accuracy with regard to the flood models and building inventories, and to test and refine the processes and methodologies used for the elements of the plan.

Phase II also relied heavily on input from a 12-member Citizen Review Committee (CRC) which met approximately every month throughout a nine-month period. The committee consisted of residents living in the floodplain who have been impacted by flooding. The CRC also fulfilled a vital role as a "sounding board" for the discussion of ideas and cross-checks to make sure that proposed thoughts, details, and approaches made good sense. Significant changes were made as a result of the pilot study and CRC input.

Plan maintenance is critical to the longevity and useful life of the Flood RA/RR Plan. The plan results will be maintained and updated in a digital environment. The fundamental concepts contained within this plan document will continue to serve as the foundation of the plan, while the property specific plan results will change over time. These results, such as Flood Risk

Property Scores, Risk Reduction Recommendations, and Flood Mitigation Priority Scores will be periodically updated under two main circumstances:

1. ***Data changes or corrections*** to the supporting information occur that could result in changes to the property specific plan results.
2. ***Adjustments to computations*** are deemed necessary by staff to provide more accurate results.

At a minimum, once per year, all the datasets will be reviewed for changes and if necessary, the plan results will be updated. If CMSWS obtains more accurate property data for individual properties, the plan results can be updated immediately. In addition, changes to the computations, multipliers, weighting, etc. may be necessary to provide more accurate results. If adjustments are made, they will be documented and the subsequent Flood Risk Property Scores, Risk Reduction Recommendations, and Flood Mitigation Priority Scores will be updated.

The data contained within this plan will be populated as new floodplain maps become available. The initial results for approximately 40 percent of the County will be available around May 2012. By early 2013, results for an additional 40 percent of the County should be available. The remaining 20 percent of the County is at the least flood risk and should be completed within 2-3 years.

The Flood RA/RR Plan coupled with a balanced and adequately funded Flood Mitigation Capital Improvement Program (CIP) will continue to successfully reduce flood risk in Mecklenburg County. CMSWS will use the plan to:

- Guide the CIP
- Identify properties at greatest flood risk
- Identify mitigation strategies
- Prioritize projects
- Highlight potential eligibility for FEMA grants

In addition, the plan results will help increase the public's awareness of flood risk make more informed decisions that could reduce their individual flood risk. This plan will support CMSWS continued efforts to engage in risk-based mitigation planning that results in sustainable actions aimed at reducing or eliminating risk to life and property from flooding. As this plan is put into action, there will be a measurable reduction in our vulnerability to flooding and Mecklenburg County will continue to become a more sustainable and flood resilient community.

Section 1 Introduction

1.1 Background

Charlotte-Mecklenburg Storm Water Services (CMSWS) manages and maintains the regulated floodplains within the City of Charlotte, the towns of Cornelius, Davidson, Huntersville, Matthews, Mint Hill, and Pineville, and the unincorporated areas of Mecklenburg County.

CMSWS aims to serve the citizens of Mecklenburg County by reducing the potential for loss of life and property due to flooding, while enhancing the natural and beneficial functions of the floodplain along streams regulated by the Federal Emergency Management Agency (FEMA). There are over 4,000 structures in approximately 350 miles of regulated streams within the County. The CMSWS Flood Mitigation Program reduces flood risk to people and property through a variety of programmatic strategies, including: enforcing floodplain regulations, maintaining floodplain maps, providing advanced flood notification to emergency responders, assessing flood risk, developing mitigation plans, and implementing flood hazard mitigation projects. The Flood Mitigation Program also disseminates information on flood risk and potential mitigation options to floodplain property owners and the general public as new data becomes available.

Charlotte-Mecklenburg began evaluating potential flood hazard mitigation sites in the early 2000's. At that time there were many properties subject to frequent flooding and property owners were seeking solutions. Mecklenburg County's last flood hazard mitigation plan was completed in 2003, making it nine years old as of 2012. In May 2004, Charlotte-Mecklenburg completed engineering studies that evaluated flood hazard mitigation strategies in 10 of the County's most urbanized watersheds. This study primarily used two sets of criteria to evaluate the different improvement alternatives—location in relation to the Community Encroachment Area Boundary (0.1' Floodway) and cost effectiveness (Benefit-Cost Ratio). As a secondary consideration, the study also evaluated flood mitigation techniques for flood reduction capability, constructability, social/environmental impacts, and hydraulic impacts in a broad sense.

The Flood Hazard Mitigation Plan in place at the time considered six flood hazard mitigation strategies: acquisition/demolition (buyouts), structure elevation, floodproofing, infrastructure improvements, flood barriers such as a levee or floodwall, and no action. Property acquisition and structure demolition was the most frequent flood mitigation technique recommended in that plan.

The successful implementation of the buyout strategy in the previous Flood Hazard Mitigation Plan, coupled with FEMA's narrow view of the financial "benefits" of mitigation, has created an opportunity to reprioritize remaining flood-prone buildings and re-evaluate strategies to reduce the flood risk. The updated strategy established in this plan is not predominantly focused on properties that meet FEMA's cost-benefit criteria. The ***Flood Risk Assessment and Risk Reduction Plan*** (Flood RA/RR Plan) includes a new approach to evaluating flood risk for each flood-prone property and prioritizing future mitigation projects and project areas. To summarize, it includes a more comprehensive, holistic, and multi-disciplinary risk-based approach to risk assessment and risk reduction.

In addition, the County's updated all-hazard mitigation plan, adopted by the Mecklenburg County Board of Commissioners on June 15, 2011, identified this Flood RA/RR Plan as a mitigation action:

> *"Mecklenburg County Mitigation Action 3 – Complete and begin implementation of detailed Flood Hazard Mitigation Plan which will identify specific mitigation options based on risk factor scoring utilizing public and private funding."*

The all-hazard mitigation plan meets the requirements of the Disaster Mitigation Act of 2000, FEMA, and the State of North Carolina, but does not reflect the detailed, comprehensive evaluation of the flood hazard included in this Flood RA/RR Plan.

1.2 Purpose

The purpose of the Flood RA/RR Plan is to recommend a more comprehensive range of specific flood mitigation techniques at the building/parcel level and to assist private property owners and local government officials in making informed decisions about flood mitigation strategies. In short, the purpose of the Flood RA/RR Plan is to assist in identifying, prioritizing, and planning future flood mitigation projects. It is the vision of CMSWS that this plan will be a "digital plan" and as such will be updated when new data becomes available. Examples of data that can change over time include property specific data such as Elevation Certificates, parcel information, and building footprints, as well as hazard-specific data such as flood hazard maps and velocity areas, and also environmental data, such as water quality buffers, environmental focus areas, etc.

1.3 Goals and Objectives

The Flood RA/RR Plan is designed to be a dynamic, continuously updated planning tool that will aid in identifying, prioritizing, and planning future flood mitigation projects. The goals of the plan are shown in **Figure 1**.

Figure 1: Goals and Objectives Graphic

1.4 Concept

The plan includes three main elements which link Flood Risk Property Scores at the individual property (parcel) level with Risk Reduction Recommendations that are then supported by Flood Mitigation Priority Scores. Each element builds upon the previous element to produce the results that will be stored in the plan data as described below:

- ***Flood Risk Property Score***—consists of analyzing factors related to flood impacts, storm frequency, and structure location on an individual property basis. (See Section 2.)
- ***Risk Reduction Recommendations***—consists of evaluating 19 different flood mitigation techniques deemed most appropriate for Mecklenburg County and making a planning-level recommendation of either 1) Highly Effective, Recommended, 2) Effective, 3) Further Evaluation Needed, or 4) Not Recommended. (See Section 3.)
- ***Flood Mitigation Priority Scores***—consists of assessing and accounting for community benefits and other factors based on Risk Reduction Recommendations that are not accounted for in the Flood Risk Property Score. The Flood Mitigation Priority Score is used to prioritize individual properties as well as project areas (i.e., groups, or "clusters" of properties) for mitigation activities. (See Section 4.)

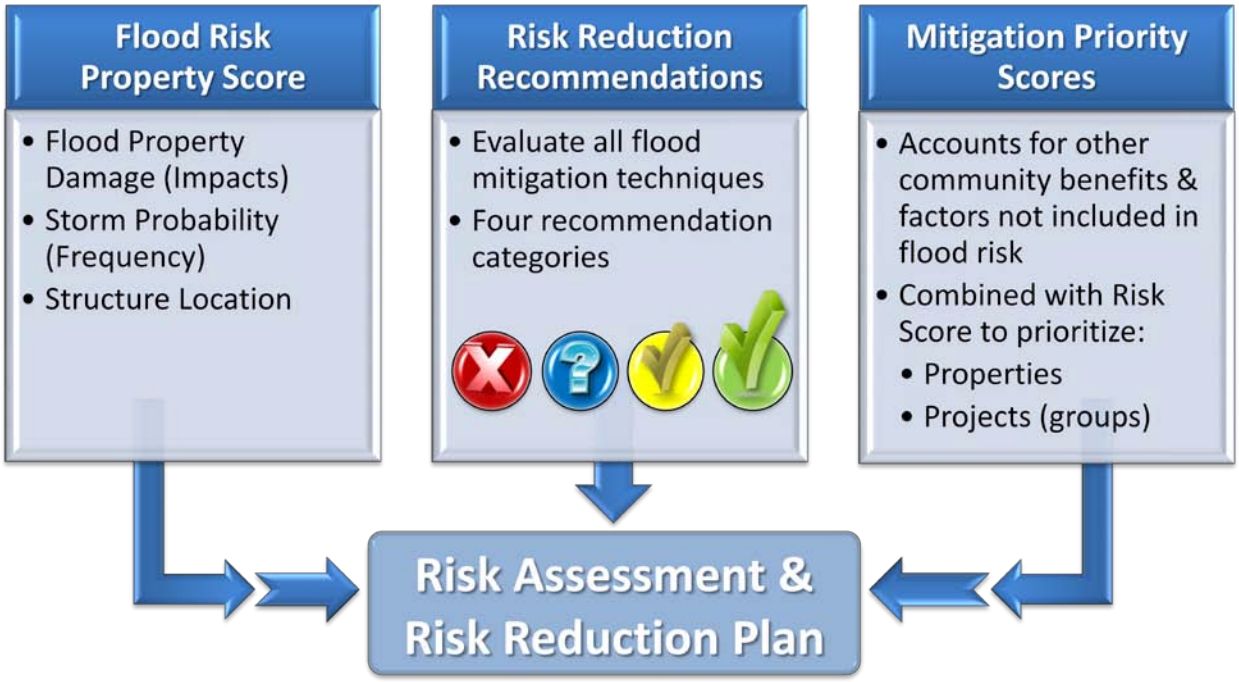


Figure 2: Concept Process Graphic

Section 2 Flood Risk Assessment

2.1 Flood Risk

Flood risk is defined as the likelihood of an event occurring (probability) times the consequences/impacts (financial, personal, and property damage) that occur. Some examples of flood impacts include damage to a building caused by flood water levels reaching the living space, heating and air conditioning equipment, ductwork in a crawlspace, or a parked car in a garage. The probability would be the likelihood that the impact will occur. Historically storm recurrence intervals are used to estimate the probability that storm water will rise to a particular elevation during a year. Storm recurrence intervals are a statistical method for predicting rainfall quantities. Using the 2-year recurrence interval (also referred to as "storm event" or "storm") as an example, there is a 50% chance that there will be a rainfall event during any given year that will cause the flood waters to equal or exceed a stated height. With a 100-year recurrence interval, there is a 1% chance a rainfall event during any given year will cause flood waters to equal or exceed a stated height. The longer the recurrence interval (100-year versus 2-year) indicates that there is a lower probability that a flood impact will occur.

2.2 Flood Risk Property Score

The purpose of the Flood Risk Scoring System (described in more detail in Section 2.3) is to develop a ***Flood Risk Property Score*** for individual properties by identifying the potential flood impacts to the property, quantifying the likelihood that the flood impact will occur, and accounting for additional risks to the structure due to location. Flood Risk Property Scores will provide information about the *relative* flood risk for the property. Members of the public, such as property owners, can use this information to assess the flood risk of their property relative to other properties. CMSWS can use the score to aid in prioritizing the flood-prone properties according to the flood risk for flood mitigation planning. The intent is to determine all flood-prone properties' relative flood risk so that CMSWS can more effectively implement flood mitigation projects.

It is important to note that the Flood Risk Scoring System developed for the Flood RA/RR Plan intentionally neglected the monetary value of what was impacted/damaged in order to normalize properties. In other words, this plan assumes that all similar impacted property (houses, cars, mechanical equipment, etc.) is of the same value. This was done to prevent disparities in the monetary value of what was damaged from dominating the Flood Risk Property Score.

2.3 Flood Risk Scoring System

The ***Flood Risk Scoring System*** consists of (1) flood impacts, (2) probability of occurrence, and (3) the location of the property, which are described in detail in the following sections and illustrated in **Figure 3**. The methodology is fairly consistent with the concept of flood risk previously described.

Figure 3: Flood Risk Property Score Illustration

2.3.1 Flood Impacts

The ***flood impacts*** are the specific types of damage that could occur as a result of flooding. The flood impacts identified in this plan are the specific consequence that could result from the flood water. Examples of flood impacts include flooding in the living space of a house, flooding of an outdoor heating or air conditioning unit, or damage to personal property such as a car. Not all impacts are directly related to property damage but have equally devastating consequences, such as the closing of a flooded street or the inability of a homeowner to leave a house surrounded by flood water.

There are 11 categories of flood impacts that have been deemed important in Mecklenburg County and are incorporated in the Flood Risk Property Score. Each impact is described below.

A. <u>Flooding Above the Lowest Floor of a Building</u>

Flooding above the lowest floor of a building can cause varying levels of damage to a structure. Even a small amount of flood water inside a house for example can damage flooring and cabinets. Higher levels of flooding can cause serious damage to sheet rock, doors, and the building's electrical systems. Long-term flooding can also result in mold and mildew that can lead to serious health issues. The flood water elevation computed using the most up-to-date HEC-RAS models or Flood Profiles included in the Flood Insurance Study (FIS) exceeds the lowest floor elevation of the building as indicated on an Elevation Certificate (see **Figure 4**).

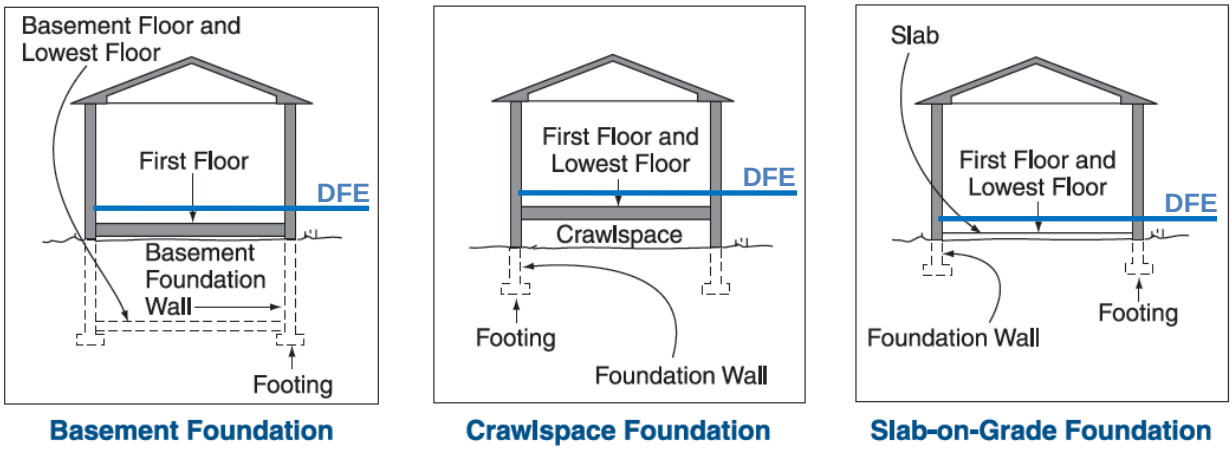


Figure 4: Examples of Flooding Above the Lowest Floor (Source: FEMA P-312)

B. Flooding of Electrical and/or Mechanical Equipment

Flooding of electrical and/or mechanical equipment can lead to costly repairs, render a residence temporarily uninhabitable, pose a fire hazard, and lead to other serious problems for a structure. The flood water elevation computed using the most up-to-date HEC-RAS models or Flood Profiles included in the Flood Insurance Study exceeds the elevation of electrical or mechanical equipment but is below the lowest floor elevation as indicated on an Elevation Certificate (see **Figure 5**). In situations where the elevation of the electrical or mechanical equipment is not available, an assumed elevation will be determined based on the foundation type, finished floor elevation, and the elevation of the lowest adjacent grade.

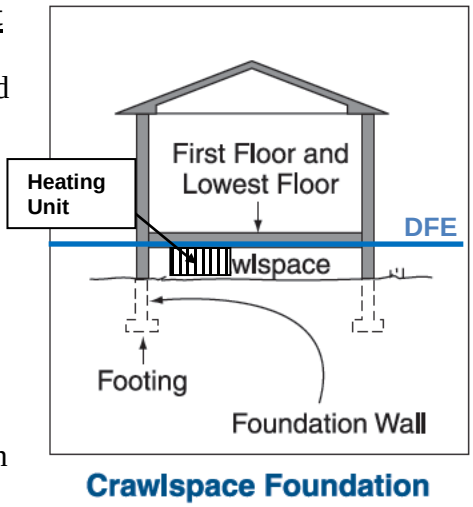


Figure 5: Example of Mechanical Equipment Flooding – DFE is Design Flood Elevation (Source: FEMA P-312)

C. Flood Water is Touching a Portion of the Building

Flood water, even if touching only a corner or portion of a building, can still cause damage, although to a lesser degree in most cases. The flood water elevation computed using the adopted HEC-RAS models or Flood Profiles included in the Flood Insurance Study exceeds the elevation of the Lowest Adjacent Grade indicated on an Elevation Certificate, but below the elevation of the electrical and mechanical equipment, and lowest floor (see **Figure 6**).

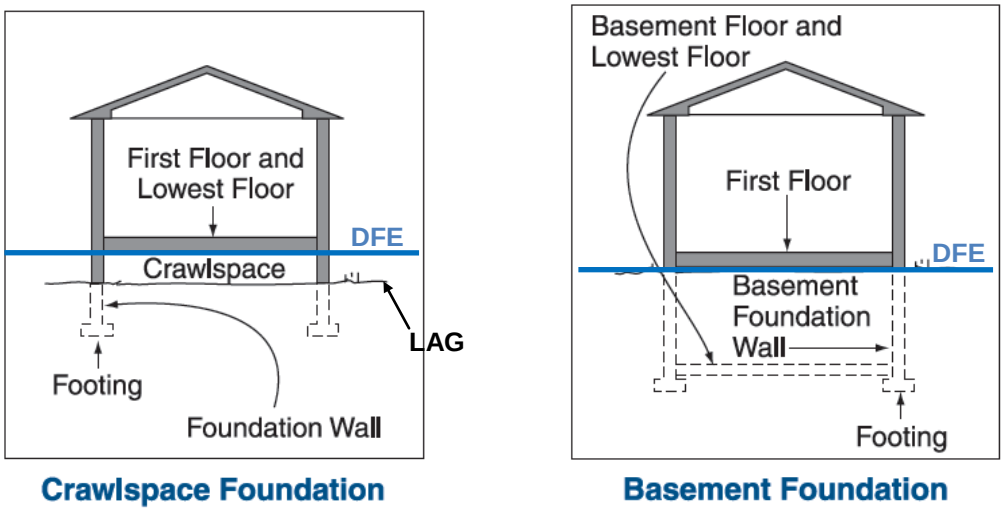


Figure 6: Example of Crawlspace Flooding (left) and Basement Flooding (right) – DFE is Design Flood Elevation
(Source: FEMA P-312)

D. Property is Completely Surrounded by Flood Water

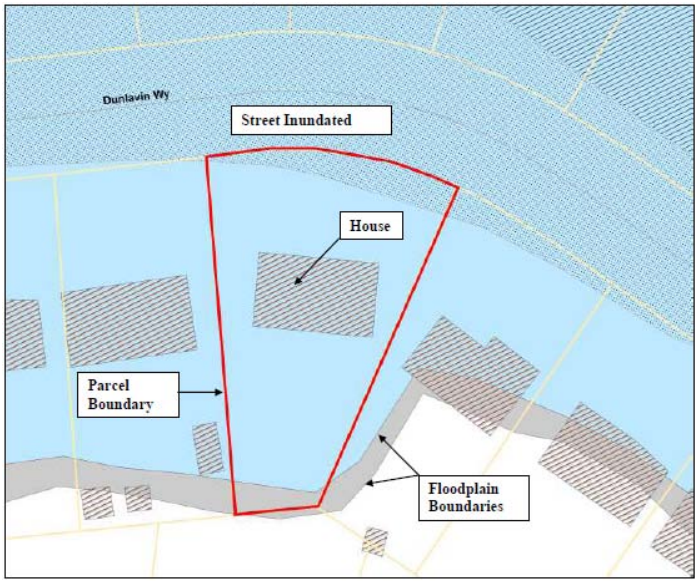


Figure 7: Example of Parcel Completely Surrounded by Flood Water from FIRM

Flood water surrounding a property, even if it does not touch the structure, can lead to serious issues related to isolation: evacuation may not be possible if conditions worsen; emergency services vehicles may be unable to reach a residence to render assistance; if flood waters stand for long periods of time isolation can lead to serious needs related to food, drinkable water, medicines and medical conditions, etc. The flood water elevation and associated floodplain boundary line computed using the adopted HEC-RAS model indicate that the entire parcel, driveway, and street are inundated by flood waters during a storm event. The focus of this flood impact is that flooded streets increase the difficulty of emergency responders to rescue people from a building. Of particular importance is the flooding of the street that provides access to the property. (See **Figure 7**.)

E. Structure is Completely Surrounded by Flood Water

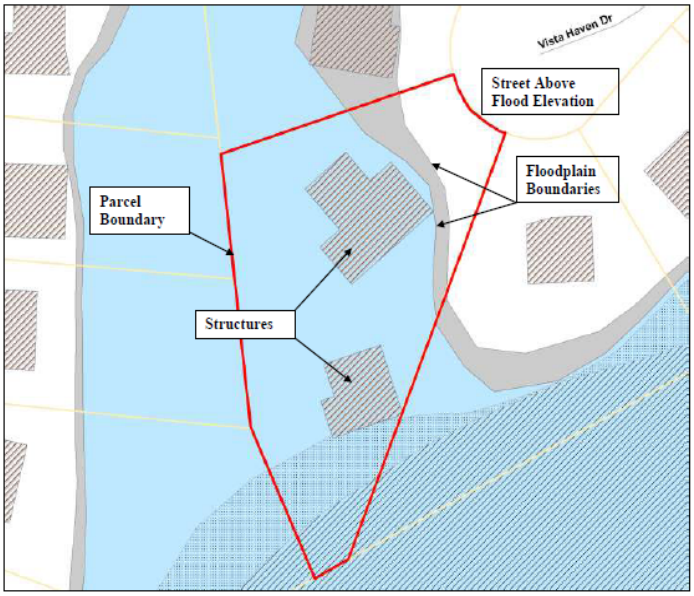


Figure 8: Example of a Structure Completely Surrounded by Flood Water From FIRM

Flood water surrounding a structure, even if it does not touch or enter the structure, can lead to serious issues related to isolation: evacuation may not be possible if conditions worsen; emergency services vehicles may be unable to reach a residence to render assistance; if flood waters stand for long periods of time isolation can lead to serious needs related to food, drinkable water, medicines and medical conditions, etc. Issues may also arise due to hydrostatic or hydrodynamic pressures exerting themselves on the structure, even if in a more indirect manner. The flood water elevation and associated

floodplain boundary line computed using the adopted HEC-RAS model indicate that the structure is completely surrounded by flood water but a portion of the parcel and the street are not inundated. (See **Figure 8**.)

F. Structure is Completely Surrounded by Flood Water AND is a Critical Facility

A critical facility is a building used to house a function that is essential to the community. Uses include but are not limited to: child and adult daycare facilities, nursing homes, schools, hospitals, fire, police, and medical facilities. Flood water surrounding a critical facility poses the additional concerns of emergency vehicles not being able to access the facility; the facility may not be able to perform its designated function; employees and staff may not be able to access the facility, etc.

G. Structure is Completely Surrounded by Flood Water AND is Multi-Family Residential

Multi-family residential buildings include apartments, condominiums, and townhouses. Multi-family buildings expose a more concentrated number of people and property to the flood risk. The points assigned to this criterion will be based on the number of units in the structure.

H. Flood Water is Touching a Portion of the Building AND has Structural Damage as a Result of Cumulative Flooding

Repeated flooding of a building can weaken, distort, and compromise the integrity of a structure. It is important to take into account the cumulative effects of multiple flood events on a structure even if these effects are not immediately apparent. A property satisfies this condition if the building has reported and verified damage such as cracking or potential damage from subsidence or shifting soil caused by flooding.

I. Flooding of Exterior Property Improvements (Moderate or Significant)

Exterior property improvements can represent substantial investments by property owners. These should be taken into account when assessing the potential impacts of a flood. This criterion only applies to single-family residential properties and is based on exterior property improvements that are deemed functional necessities to reasonable use of single-family properties. Since the amount of flood damage can vary based on the type of property improvement, there were two levels of exterior property improvements developed: “Moderate” and “Significant.” The qualifications for these are as follows and examples are shown in **Figure 9**:

1. Moderate – Property must contain:
    a. Small/standard shed (≤ 250 sf), OR
    b. At least two of the following exterior property improvements:
        i. Permanent Outdoor Play Equipment
        ii. Gazebo
        iii. Detached Carport
        iv. Yard Fencing (non-brick)
        v. Doghouse

2. Significant – Property contains one of the following items:
    a. Swimming Pool
    b. Detached Garage
    c. Large Shed or Workshop (> 250 sf)
    d. Large Outdoor Patio/Kitchen/Fireplace Area
    e. Yard Fencing (brick)

Figure 9: Example of "Moderate" Exterior Property Improvement (left) and "Significant" Exterior Property Improvement (right)

These levels are mutually exclusive, in that the property will only receive points for the highest level met. For example, if a property meets both the "Moderate" and "Significant" levels, it will only receive points for the "Significant" level (which carries the highest points). The flood water elevation and associated floodplain boundary line computed using the adopted HEC-RAS model indicate that the improvements are flooded during target storm events.

J. Flooding around Area where Single-Family Residential Vehicles are Typically Parked

Flood waters impacting a parking area, especially one associated with a single-family residential property, can lead to costly damages to vehicles; an inability to evacuate if a vehicle is damaged or inaccessible, etc. This criterion only applies to single-family residential properties because damage to vehicles occurs most often at night when residents are at home or asleep (see **Figure 10**). Vehicles parked around non-residential buildings were not included because the occupants are typically nearby and are awake while the building is in use.

The flood water elevation and associated floodplain boundary line computed using the adopted HEC-RAS model indicate that the parking area is flooded during target storm events.

Figure 10: Example of Potential Vehicle Flooding

K. Yard Flooding

Yard flooding is worthy of consideration for a variety of reasons. Flood water on the property could pose a safety hazard to children and pets; flood water standing for long periods of time can become a habitat for mosquitoes, snakes and possibly other forms of wildlife; and yard flooding can hinder access to the structure and cause damage to landscaping and other investments, etc. The latest adopted Flood Insurance Rate Map (FIRM) indicates that the yard or open space area is flooded, but the flooding does not impact any structures including garages, sheds, or other storage buildings (see **Figure 11**).

Figure 11: Example of Yard Flooding

2.3.2 Quantifying Flood Impacts

To quantify the flood impacts described in the previous section, base point values were developed to represent the potential of the flood impact for damage to property and loss of life. **Table 1** contains a list of the flood impacts criteria and the corresponding base points. The points increase with the increasing likelihood that the impact will cause loss of life or property damage. The points are also cumulative. For instance, in all cases a building with flooding of the living space will have yard flooding at a minimum. Therefore, the property would receive the points for the flooding of the living space and yard flooding

The base point values were determined from subjectively combining input from the Citizen Review Committee (discussed in Section 5.4) and estimated average damage data obtained from various sources and experience. The following assumptions were used to determine relative base points shown in **Table 1**:

- Median home value in Charlotte is approximately $200,000
- Damage is significant, but not a total loss.
- Some basic level of emergency services (if applicable) and some cost associated with human loss
- Based on the U.S. Army Corps of Engineers (USACE) depth-damage curves – Average damage from flooding below the FFE is ≈$13,000. Average damage from flooding 4 feet above the FFE is ≈$35,000
- Criteria F doubles to order of magnitude due to being a critical facility (B+C+E)
- Criteria G accounts for additional equipment, people, and vehicles due to being multi-family
- According to the Bureau of Transportation Statistics, the average value of a used vehicle in the U.S. is ≈$8,000
- Assumes two vehicles per single family residence, damaged at 50% of average value.

Table 1: Flood Impacts Criteria and Base Points

Criteria	Property Flood Impacts	Base Points
A	Flooding above the lowest **finished floor** of a building	2800
B	Flooding of **electrical and/or mechanical equipment**	1200
C	Flood water is touching a portion of the building (likely **crawlspace or unfinished basement** being impacted)	1000
D	Property is completely surrounded by flood water **(ingress/egress off of flooded property)**	1100
E	Structure is completely surrounded by flood water **(ingress/egress from building)**	500
F	Structure is completely surrounded by flood water AND is a **Critical Facility**	2700
G	Structure is completely surrounded by flood water AND is **multi-family residential (additional people, vehicles)**	1400
H	Flood water is touching a portion of the building AND has **structural damage** (subsidence, shifting, cracking) as a result of cumulative flooding	2000
I1*	Flooding of **SIGNIFICANT exterior property improvements** which are deemed functional necessities to reasonable use of single family residential property (see separate guidelines)	600
I2*	Flooding of **MODERATE exterior property improvements** which are deemed functional necessities to reasonable use of single family residential property (see separate guidelines)	300
J	Flooding around area where single-family residential **vehicles** are typically parked (see separate guidelines)	600
K	Flooding of any **yard** (any portion of parcel)	30

Note: CMSWS reserves the right to adjust these base points. in the future, as deemed necessary to maintain the integrity of the plan.

2.3.3 Probability of Occurrence

Assessment of the risk must take into account the likelihood that a particular impact would occur. Storm event recurrence interval flood data will be used to estimate the frequency of occurrence of a flood impact. The estimated flood elevations are founded on a statistical analysis of the likelihood that a watershed will receive enough rain over a certain period of time (24 hours) to produce storm water runoff sufficient to reach a flood level equal to or exceeding a certain elevation in any given year. An example of this concept is the "100-year storm event." The 100-year storm event predicts in any given year there is a 1 percent chance that a watershed will receive enough rain to produce flood levels equal to or exceeding a specified level during a 24-hour time period. This concept is a useful tool in estimating the likelihood that a flood impact will occur. The recurrence interval is an annualized probability. There is a 1 percent chance that a 100-year storm will occur during 2012 and a 1 percent chance that a 100-year storm will occur in 2013 and so on. The storm event recurrence intervals that will be used to quantify the probability of flood impacts are listed in **Table 2**.

Table 2: Storm Event Recurrence Intervals/Annualized Probability

Storm Event	Percent Annual Chance
2-year	50%
5-year	20%
10-year	10%
25-year	4%
50-year	2%
100-year	1%
500-year	0.2%

2.3.4 Determining the Impact-based Score

The Flood Risk Property Score begins with an assessment of the flood risk for the individual property, which involves indentifying the potential flood impacts and determining the probability of each impact. The potential flood impacts are identified for the property and quantified by an Impact-based Score. This score is calculated for each impact using the base points and the storm event recurrence interval. Any criteria that are not impacted by a flood event will not receive any points. Higher scores indicate a building with more flood risk. The Impact-based score is calculated using the following formula:

$$Impact - based\ Score = Base\ Points \times Percent\ Annual\ Chance\ for\ the\ Flood\ Event$$

For example, the base points for Criteria A are 2800. A building flooded by a 2-year storm event (percent annual chance of 0.50) will receive 1400 points (2800 x 0.50 = 1400), but another building that is not flooded until the 100-year event (annual percent chance of 0.01) will receive 28 points (2800 x 0.01 = 28). A matrix of the Impact-based Scores per storm event is provided in **Appendix D**.

The Total Impact-based Score is the sum of all the ***Impact-based Scores***. The Flood Risk Property Score is calculated using the Total Impact-based Score and a location-based multiplier, which is described in the following sections.

2.3.5 Location-based Factors

In addition to the flood map data that shows the probability of flooding, there are other ***Location-based Factors*** that affect a property's flood risk. These are accounted for through a location-based multiplier. For instance, buildings that are surrounded by high velocity storm water pose a higher risk to property and lives than buildings that are not exposed to high velocity flow. Each Location-based Factor is described in detail below.

A. <u>Building Located in High/Medium Danger Depth-Velocity Zone</u>

It is an accepted principal that high velocity storm water creates a hazardous condition. Every year people die in swiftly moving storm water. Fast moving storm water damages houses, sometimes carries the houses downstream, washes cars off of flooded streets and certainly creates a hazard for people. Accepting that high velocity storm water is a hazard, it is necessary to determine a velocity or a range of velocities that represents an identifiable risk. Even casual observers during a flood event notice that the water in the middle of a stream is moving more rapidly than the water on the edge of the stream. However, it is difficult to estimate the exact point in the channel cross section where the storm water velocity is just high enough to create a danger to a person or property. **Figure 12** is an illustration of the changes in storm water velocity in a stream. The dark areas are the areas with the highest velocity. The two areas with the highest velocity are the main channel of the stream and a road to the left of the stream. Of course, there are many contributing factors to the hazard such as the height of the person, physical condition of the person, depth of the storm water, etc. For flood mitigation purposes it is necessary to generalize the hazard posed by high velocity storm water even though the determination of the storm water velocity that creates a risk is specific to an individual.

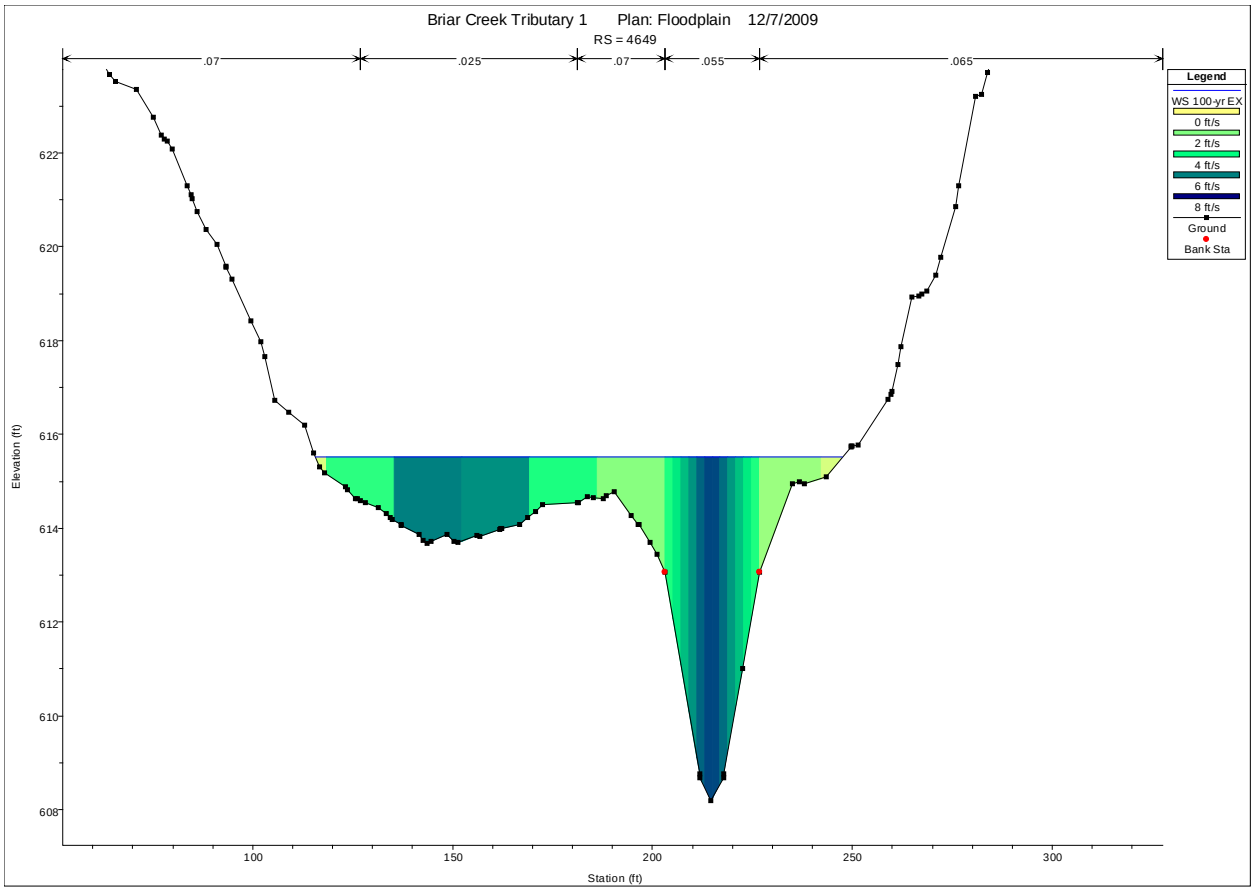


Figure 12: Illustration of Storm Water Velocities in a Stream Cross-Section

The approach being used to delineate the high and medium danger depth-velocity zones are found in a report issued in April 2010 for the Australian Rainfall and Runoff (ARR) guidelines project ("Project 10: Appropriate Safety Criteria for People, Stage 1 Report"). **Figure 13** was presented in the ARR report and shows the relationship between the depth/velocity product and hazards to pedestrians. Pedestrians are subdivided into three height/mass product categories that correspond to infants/small children, children, and adults.

DV (m^2s^{-1})	Infants, small children (H.M ≤ 25) and frail/older persons	Children (H.M = 25 to 50)	Adults (H.M > 50)
0	Safe	Safe	Safe
0 – 0.4	Extreme Hazard; Dangerous to all	Low Hazard[1]	Low Hazard[1]
0.4 – 0.6		Significant Hazard; Dangerous to most	
0.6 – 0.8		Extreme Hazard; Dangerous to all	Moderate Hazard; Dangerous to some[2]
0.8 – 1.2			Significant Hazard; Dangerous to most[3]
> 1.2			Extreme Hazard; Dangerous to all

[1] Stability uncompromised for persons within laboratory testing program at these flows (to maximum flow depth of 0.5 m for children and 1.2 m for adults and a maximum velocity of 3.0 ms^{-1} at shallow depths).
[2] Working limit for trained safety workers or experienced and well equipped persons (D.V < 0.8 m^2s^{-1})
[3] Upper limit of stability observed during most investigations (D.V > 1.2 m^2s^{-1})

Figure 13: Flow Hazard Regimes for Infants, Children, and Adults

In order to establish two velocity hazard zones for Location-based Factors, the zone indicating significant hazard to children will be used for the medium danger depth-velocity zone and the zone indicating significant hazard to adults will be used for the high danger depth-velocity zone.

B. Building Located Near Area Impacted by Storm Drainage Overflows

Storm drain systems are generally designed for smaller storm events. During storm events that fill the creek, water levels may rise above storm drain system outlets. This results in water backing up into the storm drain system and surcharging out of the upstream drainage inlet. These upstream inlets that overflow are commonly located at a low point in a street and water floods the road and flows over land towards the stream. Structures located in the vicinity of these low areas between the stream and storm drain inlet can be impacted by this over land flow. This situation can occur during smaller, more frequent storm events and is not reflected on floodplain maps.

C. Building Location in Community Encroachment Area

Structures located in the Community Encroachment Area are also subject to additional risk due to the proximity of the structures to the stream. Community Encroachment Areas are delineated by assuming that there will be development in the floodplain over time. The current Floodplain Ordinance allows property owners to build in the floodplain area outside of the Community Encroachment Area. Building often includes filling of low areas with soil which reduces the storage volume for storm water by eliminating areas with low velocity storm water. The reduction in storm water storage results in an increase in flood levels downstream of the fill. Therefore, structures located in the Community Encroachment Area are more likely to have worse flooding conditions over time. For these reasons structures located in the Community Encroachment Area will be given a higher Flood Risk Property Score. **Figure 14** shows a building located within the Community Encroachment Area as shown on the adopted Flood Insurance Rate Map.

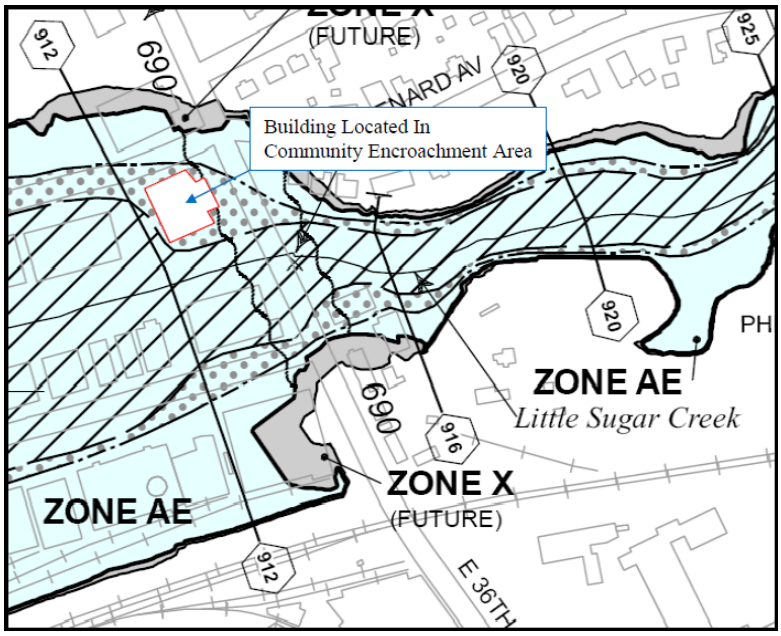


Figure 14: Example of Building Located in the Community Encroachment Area from Flood Insurance Rate Map

2.3.6 Applying the Location-based Factor

The Flood Risk Property Score is calculated by multiplying the Location-based Factor to the Total Impact-based Score. **Table 3** shows the Location-based Factors and the associated multiplier.

Table 3: Location-based Multipliers

Multiplier	Location-based Factor
1.5	Building located in high danger depth-velocity zone
1.3	Building located in medium danger depth-velocity zone
1.3	Building located near area impacted by storm drainage overflows
1.1	Building located in Community Encroachment Area

The Location-based Factor that applies to the property with the highest multiplier will be used to calculate the Flood Risk Property Score. The formula for the Flood Risk Property Score is:

$$Flood\ Risk\ Property\ Score = Total\ Impact - based\ Score \times Location - based\ Multiplier$$

For example, a building has a Total Impact-based Score of 500. If a building is located in a medium danger depth-velocity zone and the Community Encroachment Area, the highest multiplier of 1.3 is used. The Flood Risk Property Score for the building is 650 (500 * 1.3).

An example calculation of the Flood Risk Property Score is provided in the following section.

2.4 Flood Risk Property Score Example Calculation

In order to explain the application of the Flood Risk Scoring System, an example calculation of the Flood Risk Property Score is as follows:

Assume a single-family residential home has the following:

- Finished Floor Elevation – 622.6
- Lowest Adjacent Grade Elevation – 619.8
- Lowest Mechanical Equipment Elevation – 620.6
- Flood Event Elevations:
  - 2-year – 618.1
  - 5-year – 619.0
  - 10-year – 620.4
  - 25-year – 620.8
  - 50-year – 621.2
  - 100-year – 621.4
  - 500-year – 622.0

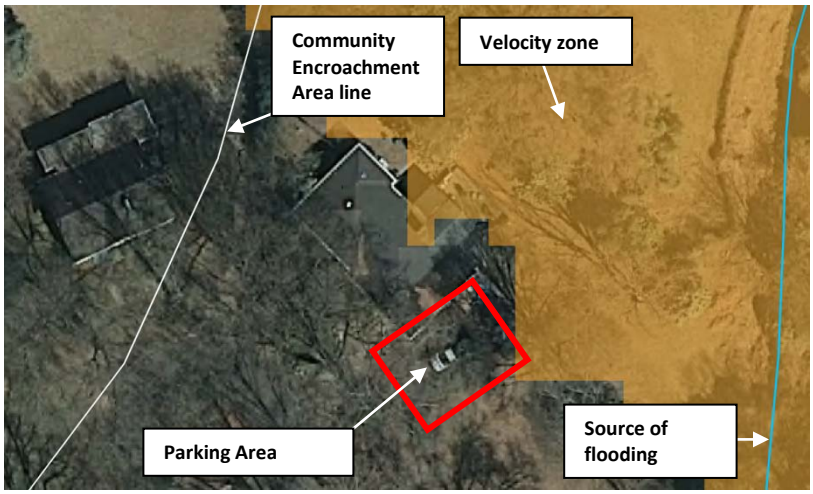


Figure 15: Flood Risk Scoring System Example

Criteria	Impact-based Factors	Storm Event	Points*
A	Flooding above the lowest finished floor of a building	N/A	0
B	Flooding of electrical and/or mechanical equipment	25-yr	48
C	Flood water is touching a portion of the building	10-yr	100
D	Property is completely surrounded by flood water	25-yr	44
E	Structure is completely surrounded by flood water	25-yr	20
F	Structure is completely surrounded by flood water and is a critical facility	N/A	0
G	Structure is completely surrounded by flood water and is multi-family residential	N/A	0
H	Flood water touching building with structural damage as a result of cumulative flooding	N/A	0
I1	Flooding of *significant* exterior property improvements	10-yr	60
I2	Flooding of *moderate* exterior property improvements	N/A	0
J	Flooding around area where single-family residential vehicles are typically parked	10-yr	60
K	Flooding of any yard (any portion of parcel)	2-yr	15
	Total Impact-based Score		**347**

* Points are determined using the matrix provided in Appendix D.

Multiplier	Location-based Factors	
1.5	Building located in high danger depth-velocity zone	No
1.3	Building located in medium danger depth-velocity zone	Yes
1.3	Building located near area impacted by frequent storm drainage overflows	No
1.1	Building located in Community Encroachment Area	Yes

Flood Risk Property Score = 347 x 1.3 = 451

Although this property meets two Location-based Factors, only the highest multiplier is applied to the Impact-based Score. Therefore, the location multiplier of 1.3 is applied to the Impact-based Score, which results in a Flood Risk Property Score of **451**.

Section 3 Risk Reduction Recommendations

3.1 Purpose

Reducing flood risk is one of CMSWS' primary goals. This can be accomplished by reducing the probability of flooding (typically through "structural" man-made alterations) *or* by reducing the consequences/impacts that will result when a flood does occur. Generally speaking, it is rare to find one mitigation technique that is appropriate for all flood-prone structures within a community. Some techniques, such as acquisition/demolition (buyout), can eliminate large numbers of worst-case properties. However, as local programs evolve, it becomes necessary to evaluate a broader range of techniques in order to arrive at ***Risk Reduction Recommendations*** that target the full range of flood-prone properties throughout the planning area. For the purposes of this plan, 19 mitigation techniques have been identified and determined to be appropriate for Mecklenburg County.

These mitigation techniques may provide a complete solution by eliminating flood risk, while others may be partial solutions by reducing flood risk. Acquisition/demolition, for example, removes the structure and its inhabitants from that particular hazard area, thus eliminating the flood risk. Elevation, however, simply *reduces* the flood risk because the structure and its inhabitants are still located in the same hazard area. Recognizing that the implementation of a single flood mitigation technique in all situations is not possible, a reduction in flood risk may be accomplished by implementing several flood mitigation techniques.

Not all mitigation activities have to be identified, driven, and/or funded by government entities, whether Federal, state, or local. Property owners place large investments in their property and are essentially the primary stakeholder. The Risk Reduction Recommendations contained within the plan data are intended to be used by both CMSWS and individual property owners as a guide to take action(s) aimed at reducing or eliminating flood risk. Some actions will also lead to lower flood insurance premiums and can make properties more valuable.

3.2 Flood Mitigation Techniques

The term ***flood mitigation technique*** is used to describe a specific project type that could be used in a given situation to reduce flood risk. The key to any flood hazard mitigation plan is implementing actions that will eliminate or reduce flood risk. Therefore, mitigation recommendations will be made for each flood-prone property. Many properties will have more than one flood hazard mitigation technique that can be employed to reduce or eliminate the flood risk.

It is also important to note that these are *planning level* recommendations and subject to the availability and quality of data. CMSWS will evaluate the recommended techniques before implementing any mitigation project.

The 19 mitigation techniques contained within this Flood RA/RR Plan were deemed most appropriate for Mecklenburg County and are described in detail in the following sections.

3.2.1 Property Acquisition and Structure Demolition (Buyout)

Property acquisition and structure demolition involves the purchase of a flood-prone structure and underlying land and demolition of the structure by a demolition contractor. The flood-prone structure is demolished and the debris is removed from the site. The site is graded to accommodate local runoff and grass is planted to promote long-term stability of the soil. When FEMA funds are used to purchase the property, the property is deed-restricted in perpetuity as open space to preserve the natural function of the floodplain.

Figure 16: Example of Demolition in Progress – Cavalier Apartments

Possible funding sources include:

- FEMA Eligible Activity
- Local Government
- NFIP ICC Fund if eligible

Advantages of this technique include:

- Completely removes people and property from the flood risk
- Property is available for use as open space, greenway, park, sanitary sewer project, water quality project or other similar uses
- Removal of structure and impervious surfaces improves water quality in the watershed

Disadvantages of this technique include:

- Purchase of the land and building and paying for demolition is costly
- Government owned land is removed from the tax base
- A large portion of the demolition debris is taken to a landfill
- If purchased with FEMA funds, land must be used as open space—cannot resale.

Criteria include:

- Structure is pre-FIRM or post-FIRM with a finished floor elevation lower than the Flood Protection Elevation[1]
- Property has a Flood Risk Property Score ≥ 300
- Property is located adjacent to publicly owned land
- Any part of the structure is located in a water quality buffer
- Property has a Flood Risk Property Score ≥ 500
- Property is located at potential water quality capital improvement site
- Property is located in critical needs area of planned greenway, park, sanitary sewer line, or water line
- Property has a Flood Risk Property Score ≥ 700

[1] The Flood Protection Elevation, or FPE, is defined for the purposes of this plan as the future 100-year flood elevation plus 1 foot of freeboard.

3.2.2 Structure Demolition and Rebuild (Demo Rebuild)

Structure demolition and rebuild involves the demolition of a flood-prone structure and the construction of a floodplain regulatory compliant structure on the same property. The rebuilt structure is either located outside the floodplain on the same parcel or built above the Flood Protection Elevation (FPE) inside the floodplain and is compliant with the Floodplain Ordinance.

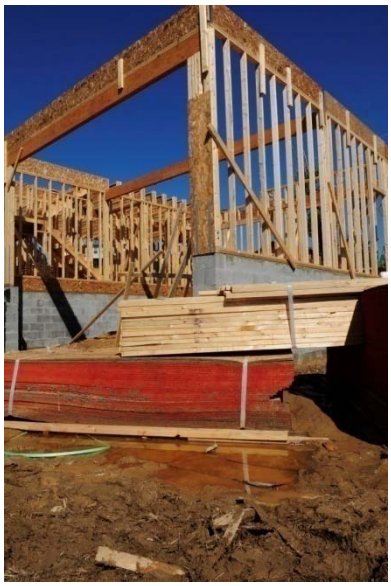


Figure 17: Example of a Demo Rebuild Project

Possible funding sources include:

- FEMA Eligible Activity
- Local Government may be available in the future
- Private/Owner
- Community Development Block Grant

Advantages of this technique include:

- Decreases the flood threat to people and property
- Less expensive than demolition or relocation because the government does not purchase the land and building
- Property remains in the tax base

Disadvantages of this technique include:

- Does not completely eliminate flood risk for people and property
- The property is not available for public uses such as open space, greenway, park, sanitary sewer project, water quality project or other similar uses
- Does not improve water quality by removing impervious surface from the watershed
- Personal property such as a car may not be protected
- A storm event with a flood elevation greater than the FPE would cause damage

Criteria include:

- Land area outside the FEMA Floodway is large enough to accommodate 1.5x the footprint of the structure (to account for setbacks)
- Land area outside the high velocity zone is 1.5x the footprint of the structure
- Land area outside the water quality buffer is large enough to accommodate 1.5x the footprint of the structure
- Building tax value is $\leq$ $30,000
- Building grade is Below Average
- Land tax value is $\geq$ 3x the building tax value
- Property is not surrounded by water during the FEMA Base Flood
- Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line
- Property is not located at a potential water quality capital improvement site

Notes:

- Must be a Severe Repetitive Loss property to be eligible for FEMA funds

3.2.3 Property Acquisition and Structure Relocation (Relocation)

Property acquisition and structure relocation involves the purchase of the land underlying a flood-prone structure and relocating the structure to a location outside the floodplain. When public funds are available, a local government entity may acquire the land. The structure would be moved to a location outside the floodplain and remains the property of a private owner. The private owner bears the cost of acquiring a new parcel for the structure and the local government entity may bear the structure relocation costs. When FEMA funds are used to purchase the land, the flood-prone land must be deed-restricted in perpetuity as open space to preserve the natural function of the floodplain.

Figure 18: Example of House Relocation

Possible funding sources include:

- FEMA Eligible Activity
- Local Government
- Private/Owner
- NFIP ICC fund if eligible

Advantages of this technique include:

- Completely removes people and property from the flood risk
- Property is available for use as open space, greenway, park, sanitary sewer project, water quality project or other similar uses
- Relocation is a reuse of the building—no demolition debris for the landfill
- Less costly than acquisition and demolition

Disadvantages of this technique include:

- Government owned land is removed from the tax base
- If purchased with FEMA funds, land must be used as open space—cannot resale land
- Difficulty in transporting building from existing lot to a new lot

Criteria include:

- Structure is pre-FIRM or structure is post-FIRM and has finished floor elevation lower than the Flood Protection Elevation
- Structure foundation is not slab-on-grade
- Structure does not have masonry walls (Cement Block/Split-Face Block, Concrete block, Jumbo/Common Brick, Precast Panel, Reinforced Concrete, or Stone)
- Building tax value is > $30,000
- Property has Risk Score ≥ 300
- Structure is a single story (no split levels or multi-story)

- Structure footprint is ≤ 2000 sf
- Property is located adjacent to publicly owned land
- Any part of the structure is located inside a water quality buffer
- Property has Risk Score ≥ 500
- Structure footprint is ≤ 1500 sf
- Property is located in critical needs area of planned greenway, park, sanitary sewer line, or water line
- Property is located at a potential water quality capital improvement site
- Property has Risk Score ≥ 700

Notes:

- New building site must be outside the Special Flood Hazard Area

3.2.4 Property Acquisition, Demolition or Relocation, and Re-sale (Buyout Resale)

Property acquisition, demolition or relocation, and re-sale involves the purchase of a flood-prone structure and underlying land and the demolition or relocation of the structure to a location outside the floodplain. When public funds are available, a local government entity may acquire the land for resale later. There would be no deed restriction on the deed that passes from the private property owner to the government entity. Therefore, the government entity could sell the portion of the property that is outside the floodplain, and retain the portion inside the floodplain.

Possible funding sources include:

- Local Government
- Private/Owner
- Community Development Block Grant

Advantages of this technique include:

- Completely removes people and property from the flood risk
- When government is involved, portion of property retained by the government is available for use as open space, greenway, park, sanitary sewer project, water quality project or other similar uses
- When government is involved, portion of property sold to private owner remains in the tax base
- When government is involved, government recoups some of the expense for purchase and demolition or relocation by the sale of a portion of the property

Disadvantages of this technique include:

- Initial cost is high to purchase the property and demolish or relocate the building
- Demolition produces debris for the landfill
- Relocation requires a willing buyer for the structure
- Cannot obtain a FEMA grant for this type of project
- Government owned portion of the property is removed from the tax base

Criteria include:

- Structure is pre-FIRM or structure is post-FIRM and has finished floor elevation lower than the Flood Protection Elevation
- Resale portion of property outside the Community Encroachment Area is ≥ 1 acre for commercial, industrial, or retail zoned property or ≥ ½ acre for residential zoned property
- Property has Risk Score ≥ 300
- Property is located adjacent to publicly owned land
- Any part of the structure is located inside a water quality buffer
- Property has Risk Score ≥ 500
- Property is located in critical needs area of planned greenway, park, sanitary sewer line, or water line
- Property is located at a potential water quality capital improvement site
- Property has Risk Score ≥ 700

3.2.5 Structure Elevation (Elevation)

Structure elevation consists of physically raising the lowest finished floor of an existing structure to an elevation above the Flood Protection Elevation (FPE). Elevation may be achieved by a variety of methods including piles, posts, and columns, or elevating on fill. Foundations must be designed to properly withstand all loads. The elevated structure must be properly anchored to the foundation and utilities must be elevated above the FPE.

Figure 19: House During Elevation Process

Possible funding sources include:

- FEMA Eligible Activity
- Local Government may be available in the future
- Private/Owner
- NFIP ICC fund if eligible

Figure 20: Completed Elevation of House

Advantages of this technique include:

- Decreases the flood threat to people and property
- Less expensive than demolition or relocation because the government does not purchase the land and building
- Less disruptive to the property owners
- Does not add debris to the landfill
- Property remains in the tax base

Disadvantages of this technique include:

- Does not completely eliminate flood risk for people and property
- The property is not available for public uses such as open space, greenway, park, sanitary sewer project, water quality project or other similar uses
- Requires more coordination time between CMSWS staff and property owners
- Does not improve water quality by removing impervious surface from the watershed
- Personal property, such as a car, may remain susceptible to flooding
- A storm event with a flood elevation greater than the FPE would cause damage
- Does not decrease the need to coordinate with CMEMO on the notification, evacuation and/or provision of emergency response or protective measures for building occupants during flood events

Criteria include:

- Structure is not located in an area with high-velocity flows
- Structure is outside the FEMA Floodway
- Structure is not a split-level
- Elevation height is 0-9 ft. (FPE - FFE = 0-9 ft.)
- Structure is located outside any water quality buffer
- Property is not surrounded by water during the FEMA Base Flood
- Structure foundation is not slab-on-grade
- Building tax value is > $30,000
- Building grade is Average, Good, Very Good, Excellent, or Custom
- Land tax value is < 3x the building tax value
- Structure is not surrounded by flood water during the FEMA Base Flood
- Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line
- Property is not located at a potential water quality capital improvement site

3.2.6 Abandon Basement and Fill (Fill Basement)

Abandon basements and fill involves raising the lowest finished floor of an existing structure to an elevation above the Flood Protection Elevation (FPE) by converting the finished basement to crawlspace. This may be achieved by abandoning the basement and filling to create a crawlspace. Fill would be needed around the exterior perimeter of the foundation. The structure must be modified to allow filling in basement and utilities must be elevated above the FPE.

Possible funding sources include:

- FEMA Eligible Activity
- Local Government may be available in the future
- Private/Owner

Advantages of this technique include:

- Decreases the flood threat to people and property
- Less expensive than acquisition, demolition or relocation because the government does not purchase the land and building

- Less disruptive to the property owners
- Does not add debris to the landfill
- Property remains in the tax base
- Results in a fully compliant building

Disadvantages of this technique include:

- Does not completely eliminate flood risk for people and property
- The property is not available for public uses such as open space, greenway, park, sanitary sewer project, water quality project or other similar uses
- Requires more coordination time between CMSWS staff and property owners
- Does not improve water quality by removing impervious surface from the watershed
- A storm event with a flood elevation greater than the FPE would cause damage

Criteria include:

- Structure is not located in an area with high-velocity flows
- Structure is outside the FEMA Floodway
- Structure has a basement
- Next Higher Floor is ≥ FPE
- Structure is located outside any water quality buffer
- Property is not surrounded by water during the FEMA Base Flood
- Structure is not surrounded by flood water during the FEMA Base Flood
- Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line
- Property is not located at a potential water quality capital improvement site

Notes:

- Not a typical technique but could be FEMA eligible as an elevation project

3.2.7 Dry Floodproofing of Structures (Dry Floodproofing)

Dry floodproofing of a structure involves making any area below the Flood Protection Elevation (FPE) watertight to prevent floodwater from entering the structure. The walls must be made watertight with waterproof coatings, impermeable membranes, and/or supplemental layers of concrete or masonry. Any windows, doors, or other openings must be equipped with permanent or removable shields. Water and sewer lines must be equipped with backflow preventer valves. All mechanical and electrical equipment must be flood protected either by a floodproofing enclosure or by elevating above the FPE.

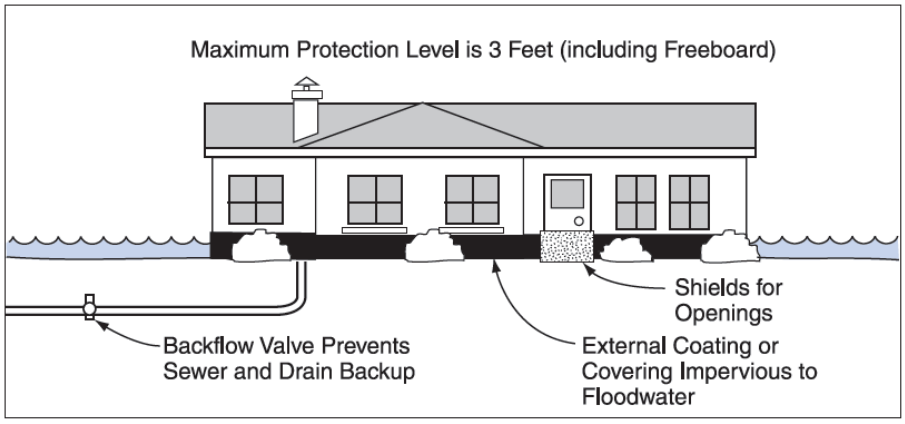


Figure 21: Example of Dry Floodproofing (Source: FEMA P-312)

Possible funding sources include:

- FEMA Eligible Activity
- Local Government may be available in the future
- Private/Owner
- NFIP ICC fund if eligible

Advantages of this technique include:

- Reduces the flood risk to property
- Businesses can remain open providing employment
- Property and building remain in the tax base

Disadvantages of this technique include:

- Does not reduce the flood risk to people
- Reduces but does not eliminate flood risk to property
- Property is not available for use as open space, greenway, park, sanitary sewer project, water quality project or other similar uses
- May be cost prohibitive if foundation modifications are involved
- May not protect personal property such as vehicles in the parking lot
- A storm event with a flood elevation greater that the FPE may cause damage

Criteria include:

- For residential pre-FIRM, the Lowest Floor is not necessarily above the FPE; for residential post-FIRM, the Lowest Floor is above the FPE
- Top of foundation wall is $\leq$ 3 ft above adjacent grade
- Flood depths are $\leq$ 3 ft
- Structure does not have a basement
- Structure has masonry or masonry veneer type walls (Cement Block/Split-Face Block, Concrete Block, Face Brick, Jumbo/Common Brick, Precast Panel, Reinforced Concrete, Stone, Brick, Brick Face)
- Structure is not located in an area with high-velocity flows
- Structure is located outside the FEMA Floodway
- Structure is not surrounded by flood water during the FEMA Base Flood

- Structure is located outside any water quality buffer
- Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line
- Property is not located at a potential water quality capital improvement site

Notes:

- FEMA funding is limited to non-residential or historic residential buildings
- Does not reduce NFIP insurance premiums
- It may result in an increase in insurance premium

3.2.8 Wet Floodproofing of Structures (Wet Floodproofing)

Wet floodproofing of a structure is accomplished by modifying the areas of an existing structure to allow water to enter the space, but not cause significant damage. Water is allowed to enter the impacted area such as a crawl space to equalize the hydrostatic pressure. The area that is inundated during the flood event must be made to properly drain when the flood water recedes. All construction and finish materials in the inundated areas must be flood resistant materials. Another element of wet floodproofing is the relocation of mechanical and electrical equipment above the Flood Protection Elevation (FPE) or the construction of a floodwall around the equipment for protection during flooding.

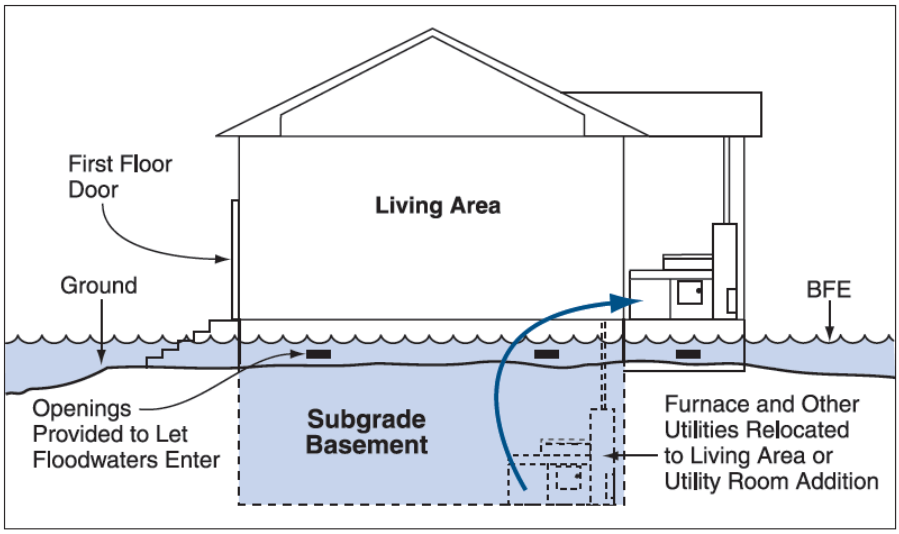


Figure 22: Example of Wet Floodproofing (Source: FEMA P-312)

Possible funding sources include:

- Local Government may be available in the future
- Private/Owner

Advantages of this technique include:

- Reduces the flood risk to property
- Businesses may remain open providing employment
- Property and building remain in the tax base

Disadvantages of this technique include:

- Does not reduce the flood risk to people
- Reduces but does not eliminate flood risk to property
- Property is not available for use as open space, greenway, park, sanitary sewer project, water quality project or other similar uses
- May be cost prohibitive if foundation modifications are involved
- May not protect personal property such as vehicles in the parking lot are not protected
- A storm event with a flood elevation greater than the FPE would cause damage

Criteria include:

- Structure foundation is not slab-on-grade
- Structures does not have a finished basement
- FEMA Base Flood Elevation is < 8 ft above the Lowest Floor (basement) or LAG (crawlspace)
- Finished Floor Elevation is higher than FEMA Base Flood Elevation
- Structure is not located in an area with high-velocity flows
- Structure is located outside the FEMA floodway
- Structure is surrounded by flood water during the FEMA Base Flood
- Structure is located outside any water quality buffer
- Structure is located outside the Community Encroachment Area
- Any part of the structure is located within the FEMA floodplain
- Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line
- Property is not located at a potential water quality capital improvement site

3.2.9 Audible Flood Warning System for Individual Property (Audible Warning)

Audible flood warning system for individual property owners includes the use of electronic flood warning systems to alert individual property owners of potential flooding, typically through the use of sensors and a monitor. The flood warning system would provide the property owner with an audible warning when flood waters reach a pre-specified level. This allows the property owner enough time to vacate the property and/or protect personal property from flood damage. The flood warning system could be attached to a structure or personal property, such as a car.

Figure 23: Example of a water alert system

Possible funding sources include:

- Private/Owner

Advantages of this technique include:

- Reduces the flood risk to people and property to a limited degree
- Property and building remain in the tax base

- Typically a low cost mitigation technique

Disadvantages of this technique include:

- Very limited reduction of flood risk to property. Only the property that can be removed or somehow protected from flood waters would be impacted.
- Property is not available for use as open space, greenway, park, sanitary sewer project, water quality project or other similar uses
- Requires regular maintenance by property owner

Criteria include:

- Any part of the property is located in the Community Floodplain
- The Lowest Adjacent Grade to the structure is below the Community Base Flood Elevation
- Any part of the structure is within a high-velocity zone
- Any part of the structure is within the 25-year floodplain

3.2.10 Storm Water Detention Facilities (Detention)

Figure 24: Example of Dry Detention Basin

Storm water detention facilities include the installation of basins to detain storm water during large storm events. The detention basin reduces peak flood levels downstream of the basin. Storage of a large volume of water is necessary to have a significant impact on flood elevations during a large storm event. The detention facilities typically consist of offline storage areas directly adjacent to a stream. The storm water enters the detention facilities during more intense storms and slowly drains out of the basin using gravity operated outlet devices (no mechanical pumping systems). This technique is intended to reduce the potential flood damage to multiple structures and is not intended to benefit a single property. These projects are typically government funded because detention facilities must be very large to reduce flood levels during a large storm event, but this does not preclude a private storm water detention project.

Possible funding sources include:

- FEMA Eligible Activity
- Local Government

Advantages of this technique include:

- Limited disruption to the people and property positively impacted by the detention facility
- May have a positive impact on the flood elevations at bridges and culverts

- Basins provide a water quality benefit by reducing storm water pollutants such as suspended solids

Disadvantages of this technique include:

- Detention will reduce but not eliminate the flood risk downstream
- Must impact a large number of properties to be economically feasible
- Construction of the detention basin is costly
- Requires open space adjacent to the stream for the detention basin
- The detention basin must be maintained

Criteria include:

- Potential detention area is located in a City of Charlotte Storm Water Services priority watershed
- Approximately 4 acres or more of storage space per 1 square mile of drainage area
- Approximately 30% or more of proposed area for detention basins must be publicly owned land
- Approximately 100 structures or more with potential flood damage reduction within 2 miles downstream of the detention basin—the closer the structures are to the basin, the greater the impact required to warrant further investigation

Notes:

- Potential detention area should be located in or adjacent to publicly owned land
- Potential detention area should be located outside the FEMA Floodway
- Potential detention area should be located in area of planned greenway or park

3.2.11 Storm Water System Control (Flood Control)

This flood mitigation technique includes the replacement or modification of culverts or bridges to reduce the flooding potential caused by backwater. An undersized bridge or culvert will result in increased storm water depths upstream. This increased flood water depth is referred to as "backwater." The culvert or bridge is replaced or modified to allow more storm water to pass. This results in a reduction in the backwater upstream of the culvert or bridge, but may result in increased storm water depths downstream. These projects are typically government funded because local government or the North Carolina Department of Transportation maintains the road and bridge/culvert.

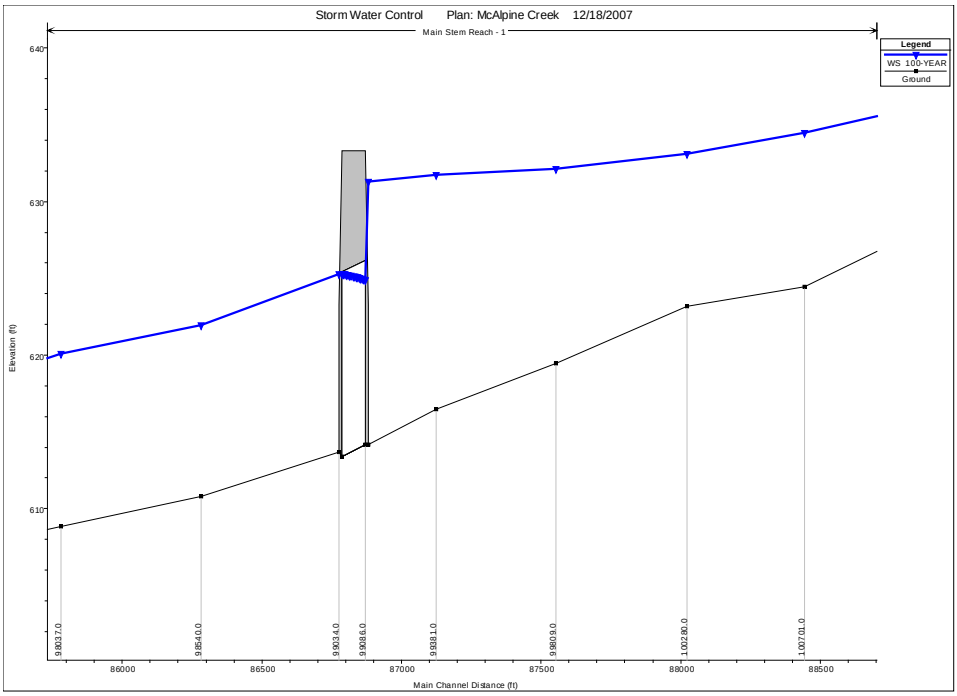


Figure 25: Example of Backwater at Culvert Shown in Profile

Possible funding sources include:

- FEMA Eligible Activity
- State Government
- Local Government

Advantages of this technique include:

- Increases in the conveyance of bridges and culverts in a backwater situation can have a significant effect on flood elevations upstream of the culvert or bridge
- Typically the bridge or culvert is owned by a governmental entity and the cost of the replacement or modification does not include land acquisition

Disadvantages of this technique include:

- The expansion of a culvert or bridge in a backwater situation may increase the flood elevations downstream of the modified structure
- Modifying or replacing culverts and bridges is costly
- Modifying or replacing culverts and bridges typically requires permitting from local, state, and Federal government

Criteria include:

- Backwater upstream of bridge or culvert impacts approximately 25 structures
- The road overtopping height to culvert opening height ratio is > 2
- Internal staff review process identifies this culvert as a concern

Notes:

- Limited number of structures immediately downstream of bridge or culvert

- Bridge or Culvert is located in 100-year floodplain
- Affected properties are not located in critical needs area of planned greenway, park, or sanitary sewer line

3.2.12 Automated Flood Notifications (FINS Notification)

CMSWS in conjunction with the USGS operates the Flood Information & Notification System (FINS) in Mecklenburg County. FINS has a network of automated rain and stream gages that constantly measure precipitation and stream depth in target streams where flooding has resulted in risk to people and damage to structures in the past. FINS automatically notifies emergency services personnel when either the rain depth or stream depth exceeds a predetermined threshold. CMSWS may build user-driven notification into FINS. CMSWS staff may provide user assistance with determining thresholds for individual properties.

Figure 26: FINS Logo

Possible funding sources include:

- Local Government

Advantages of this technique include:

- Reduces the flood risk to people and property to a limited degree
- Property and building remain in the tax base

Disadvantages of this technique include:

- Does not completely eliminate flood risk to people
- Very limited reduction of flood risk to property. Only the property that can be removed or somehow protected from flood waters would be impacted.
- Property is not available for use as open space, greenway, park, sanitary sewer project, water quality project or other similar use

Criteria include:

- Any part of the property is located in the Community Floodplain

3.2.13 Public Education (Public Education)

This mitigation technique consists of a multi-media public education campaign to inform owners of flood-prone properties of the flood risks and methods for protecting their lives and property. The focus of this effort is to teach the public strategies to protect themselves before, during, and after a flood event. Examples of the educational effort would include encouraging flood-prone property owners to purchase flood insurance, keeping storm drains clear of debris,

Figure 27: Example of Flood Safety Brochure

avoiding flooded roads, etc. The education would be accomplished through broadcast media, the storm water website, flyers, and public meetings.

Possible funding sources include:
- Local Government

Advantages of this technique include:
- Engages a large number of people in the flood mitigation process
- Empowers individual property owners to make good decisions about flood risk and flood mitigation
- Builds support necessary to further identify and fund more active type mitigation projects
- Relatively inexpensive

Disadvantages of this technique include:
- This is not an active method of flood mitigation
- Cannot be assured that contact is made with every impacted property owner

Criteria include:
- Any part of the property is located in the Community Floodplain

3.2.14 Flood Insurance (Flood Insurance)

The goal is the purchase of flood insurance through the National Flood Insurance Program for all flood-prone properties. CMSWS encourages property owners to purchase flood insurance because it is one of the best methods for limiting the individual economic damage due to flooding. FEMA requires property owners to maintain flood insurance as a requirement of receiving flood mitigation grant funding.

Figure 28: Example of Flood Insurance Promotion Poster

Possible funding sources include:
- Private/Owner

Advantages of this technique include:
- This compensates individuals for economic losses due to flooding
- This is not an expense for CMSWS

Disadvantages of this technique include:
- This technique does not reduce flood risk to property by structural physical means and does not do anything to reduce risk to life
- Flood insurance may provide a false sense of security

Criteria include:
- Any part of the property is located in the Community Floodplain

3.2.15 Levee/Floodwall Protection for Multiple Structures (Levee)

This flood mitigation technique includes the installation or modification of a major floodwall or levee system that holds back floodwaters, which eliminates or reduces the risk of flood damage to multiple structures or facilities. Typically, a floodwall or levee system consists of an earthen berm and/or floodwall constructed of flood-proof materials. The levee or floodwall is constructed between the stream and the building(s) and is meant to protect with the intention of shielding the flood-prone building(s) from storm water.

Figure 29: Levee Built around Multiple Structures

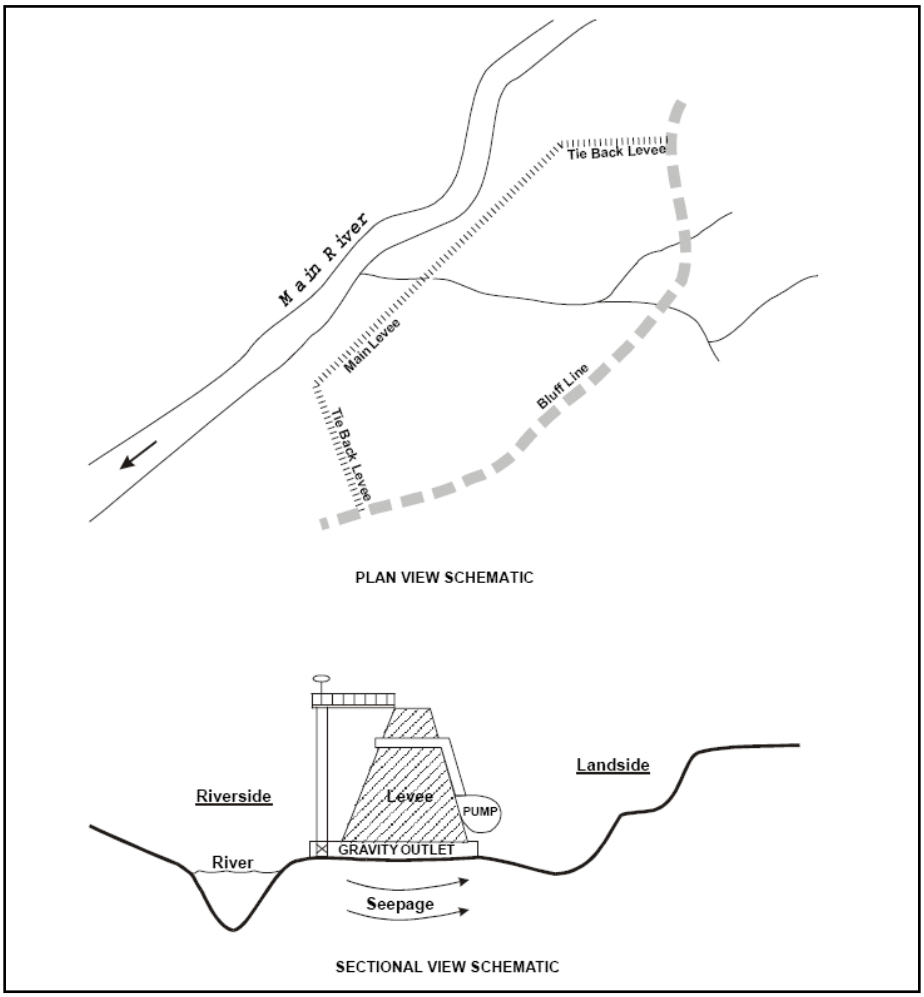


Figure 30: Plan View and Section View of Traditional Level/Floodwall System

Possible funding sources include:

- Local Government
- Private/Owner

Advantages of this technique include:

- This method allows property owners to continue to occupy their buildings
- This method leaves the properties protected by the levee or floodwall in the tax base
- This may reduce the likelihood of flooding for multiple buildings

Disadvantages of this technique include:

- Does not eliminate the threat of flooding and may provide the flood-prone property owners with a false sense of security
- Requires maintenance for the life of the levee or floodwall
- Requires local government acceptance of the floodwall or levee
- This is a costly option
- Typically, requires local, state, and Federal permits
- Will impact flood-prone structures when flood elevation exceeds design protection elevation

Criteria include:

- Property where levee/floodwall will be constructed is not located in a critical needs area of planned greenway, park, sanitary sewer line, or water line
- Property where levee/floodwall will be constructed is not located at a potential water quality capital improvement site
- Levee/Floodwall will be located outside the FEMA Floodway
- Proposed levee/floodwall would protect Habitable Buildings from flooding above the Lowest Floor during the Community Base Flood Event
- Levee/floodwall must be located on land that is not owned by a government entity
- Levee/floodwall must comply with local, state and federal requirements
- Property where levee/floodwall will be constructed is not located adjacent to publicly owned land
- Levee/floodwall will be located outside any water quality buffer

Notes:

- Construction of a Levee/Floodwall will not eliminate a significant amount of floodplain storage thus resulting in an increase in the discharge rate downstream
- Design must include interior drainage considerations and backflow preventers in cases where protected properties will be completely surrounded by flooding or there is no outfall

3.2.16 Protecting Service Equipment (HVAC, electrical, utilities, fuel) (Protecting Equipment)

Protecting service equipment involves elevating, relocating, or protecting them in place. Service equipment installed outside the structure can be raised on pedestals or platforms to an elevation above the Flood Protection Elevation (FPE). Service equipment located in a basement or other area below the flood level can be relocated to an upper floor, attic, or higher ground. Water and sewer lines can be protected with backflow preventer valves. If elevating and relocation are not possible, protecting service equipment in place may be done with low floodwalls and shields, and anchors and tie downs for aboveground and underground storage tanks.

Figure 31: Example of Elevated Utilities

Possible funding sources include:

- Private/Owner

Advantages of this technique include:

- Reduces the flood risk to property
- Property and building remain in the tax base

Disadvantages of this technique include:

- Does not reduce the flood risk to people
- Reduces but does not eliminate flood risk to property

Criteria include:

- Service equipment elevation is below the FEMA Base Flood Elevation
- FFE of main structure is above the FEMA Base Flood Elevation
- Structure is located outside the FEMA Floodway

Notes:

- FEMA HMA funding may be available if other mitigation options are evaluated and are not feasible or cost-effective

3.2.17 Partial Dry Floodproofing (Partial Dry Floodproofing)

Partial dry floodproofing of a structure involves dry floodproofing to protect from smaller storm events. This technique only reduces risk from smaller, more frequent storm events. All mechanical and electrical equipment must be flood protected either by a floodproofing enclosure or by elevating above the Flood Protection Elevation (FPE).

Possible funding sources include:
- Private/Owner

Advantages of this technique include:
- Reduces the flood risk to property
- Property and building remain in the tax base

Disadvantages of this technique include:
- Only protects from smaller storm events
- Does not reduce the flood risk to people
- Reduces but does not eliminate flood risk to property

Criteria include:
- Structure does not have a basement
- Structure has masonry or masonry veneer type walls (Cement Block/Split-Face Block, Concrete Block, Face Brick, Jumbo/Common Brick, Precast Panel, Reinforced Concrete, Stone, Brick, Brick Face, Stone)
- Structure is not located in an area with high-velocity flows
- Structure is located outside the FEMA floodway

Notes:
- This technique only reduces risk from smaller, more frequent storm events
- Dry floodproofing should not exceed 3 feet

3.2.18 Partial Wet Floodproofing (Partial Wet Floodproofing)

Partial wet floodproofing involves wet floodproofing to protect from smaller storm events. All mechanical and electrical equipment must be relocated above the Flood Protection Elevation (FPE) or protected by constructing a floodwall around the equipment.

Possible funding sources include:
- Private/Owner

Advantages of this technique include:
- This method allows the property owner to continue to occupy their building
- This method leaves the property protected by the levee or floodwall in the tax base
- This may reduce the likelihood of flooding the building

Disadvantages of this technique include:
- Only protects from smaller storm events
- Does not reduce the flood risk to people
- Reduces but does not eliminate flood risk to property

Criteria include:
- Structure foundation is not slab-on-grade

- Structures does not have a finished basement
- Structure is not located in an area with high-velocity flows
- Structure is located outside the FEMA floodway

Notes:

- This technique only reduces risk from smaller, more frequent storm events

3.2.19 Levee/Wall/Berm for a Single Structure (Ring Levee)

This technique includes the installation or modification of a floodwall or levee system on an individual property that holds back floodwaters, which eliminates or reduces the risk of flood damage to a single structure. Typically, this consists of an earthen berm and/or floodwall constructed of flood-proof materials. The levee or floodwall is constructed between the stream and the building and is meant to protect with the intention of shielding the flood-prone building from storm water.

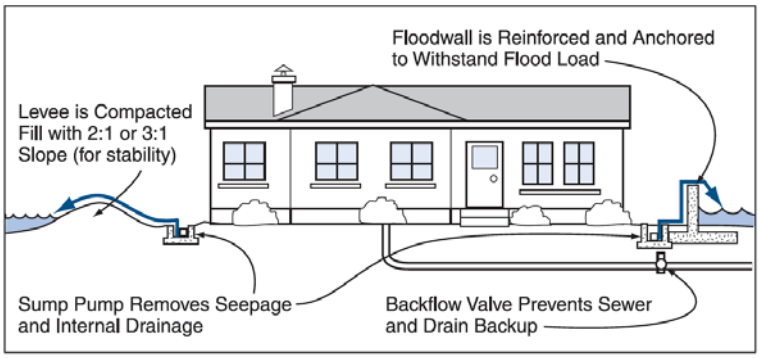


Figure 32: Levee/Flood for a Single Structure

Possible funding sources include:

- Private/Owner

Advantages of this technique include:

- This method allows the property owner to continue to occupy their building
- This method leaves the property protected by the levee or floodwall in the tax base
- This may reduce the likelihood of flooding the building

Disadvantages of this technique include:

- Does not eliminate the threat of flooding and may provide the flood-prone property owners with a false sense of security
- Requires maintenance for the life of the levee or floodwall
- Typically, requires local permits
- Does not reduce the flood risk to people
- Reduces but does not eliminate flood risk to property

Criteria include:

- Structure is located outside the Community Encroachment Area
- Structure is not surrounded by flood water during the FEMA Base Flood
- Structure is located outside any water quality buffer
- Structure is not located in an area with high-velocity flows

Notes:

- Levee/floodwall/berm must comply with local, state, and Federal requirements

3.3 Recommendation Categories

While 19 flood mitigation techniques were deemed generally appropriate for Mecklenburg County, the actual appropriateness of implementing each technique varies from property to property due to a number of site-specific factors. This plan evaluates the appropriateness of each mitigation technique for a given property using a variety of criteria that are linked to factors specific to that property, including flood hazard data and building information. These criteria help to ensure that the technical feasibility and overall effectiveness of possible mitigation techniques is considered in the evaluation of risk reduction recommendations to be made for each flood-prone property as part of this plan. The evaluation of risk reduction recommendations is further discussed in Section 3.4.

Recommendations on mitigation techniques will be made for each flood-prone property in the county. These recommendations are for planning purposes and will be reviewed in more detail as part of the project implementation process. In order to keep the recommendations structured in an easily discernible format, each mitigation technique will be evaluated and placed into one of four categories (or "buckets") for each property:

- **Not Recommended**
  The minimum criteria for the mitigation technique are not met. Therefore, the technique is likely not feasible, effective, or may be cost prohibitive.

- **Further Evaluation Needed**
  The minimum criteria for the mitigation technique are met but further evaluation or additional data is needed to determine if the technique is a viable option.

- **Effective**
  The mitigation technique was determined to be feasible and effective by exceeding the minimum criteria and meeting all of the criteria for this category.

- **Highly Effective, Recommended**
  The mitigation technique was determined to be highly effective by exceeding the criteria for the effective category and meeting all of the requirements for this category. This category was developed to identify techniques that were highly effective in reducing risk or provided an additional community benefit.

Certain mitigation techniques may not have the potential to fall into all of the four categories. For example, Flood Insurance would be a "Highly Effective, Recommended" technique for all flood-prone properties because it is one of the best methods for limiting economic damage due to flooding.

Table 4 shows the potential buckets that each mitigation technique may fall into.

Table 4: Mitigation Techniques Matrix

Mitigation Technique	Highly Effective, Recommended	Effective	Further Evaluation Needed	Not Recommended
Buyout	X	X	X	X
Demo Rebuild	X	X	X	X
Relocation	X	X	X	X
Buyout Resale	X	X	X	X
Elevation	X	X	X	X
Fill Basement	X	X	X	X
Dry Floodproofing	X	X	X	X
Wet Floodproofing	X	X	X	X
Audible Warning	X	X	X	
Detention			X	X
Flood Control			X	X
FINS Notification	X			
Public Education	X			
Flood Insurance	X			
Levee			X	X
Protecting Equipment	X	X	X	
Partial Dry Floodproofing			X	X
Partial Wet Floodproofing			X	X
Ring Levee			X	X

3.4 Evaluating the Risk Reduction Recommendations

Each property will have each technique evaluated through an automated process based on a wide variety of available data. **Figure 33** is a visual illustration of how the automated evaluation will work. Similar to a sand sifter, all the properties will be "filtered" through three categories of criteria specific to each mitigation technique. The concept is that the criteria act as filters and allows the properties meeting the criteria to move on to the next category (or bucket). This process is repeated for each mitigation technique (19 times total). For example, the minimum criteria (represented by the blue criteria) filter the properties into two buckets, "Not Recommended" (represented by the red bucket) or "Further Evaluation Needed" (represented by the blue bucket). The properties that do not meet the criteria remain in the red bucket, and the properties that meet the criteria move on to the blue bucket. The properties that are in the blue bucket must filter through the "Effective" criteria (represented by the yellow criteria) in order to move on to the "Effective" bucket (represented by the yellow bucket). This continues again with the "Highly Effective, Recommended" criteria (represented by the green criteria). At the end of this process, each property evaluated will fall into one of the four buckets. A summary of the mitigation techniques criteria is provided in **Appendix E**.

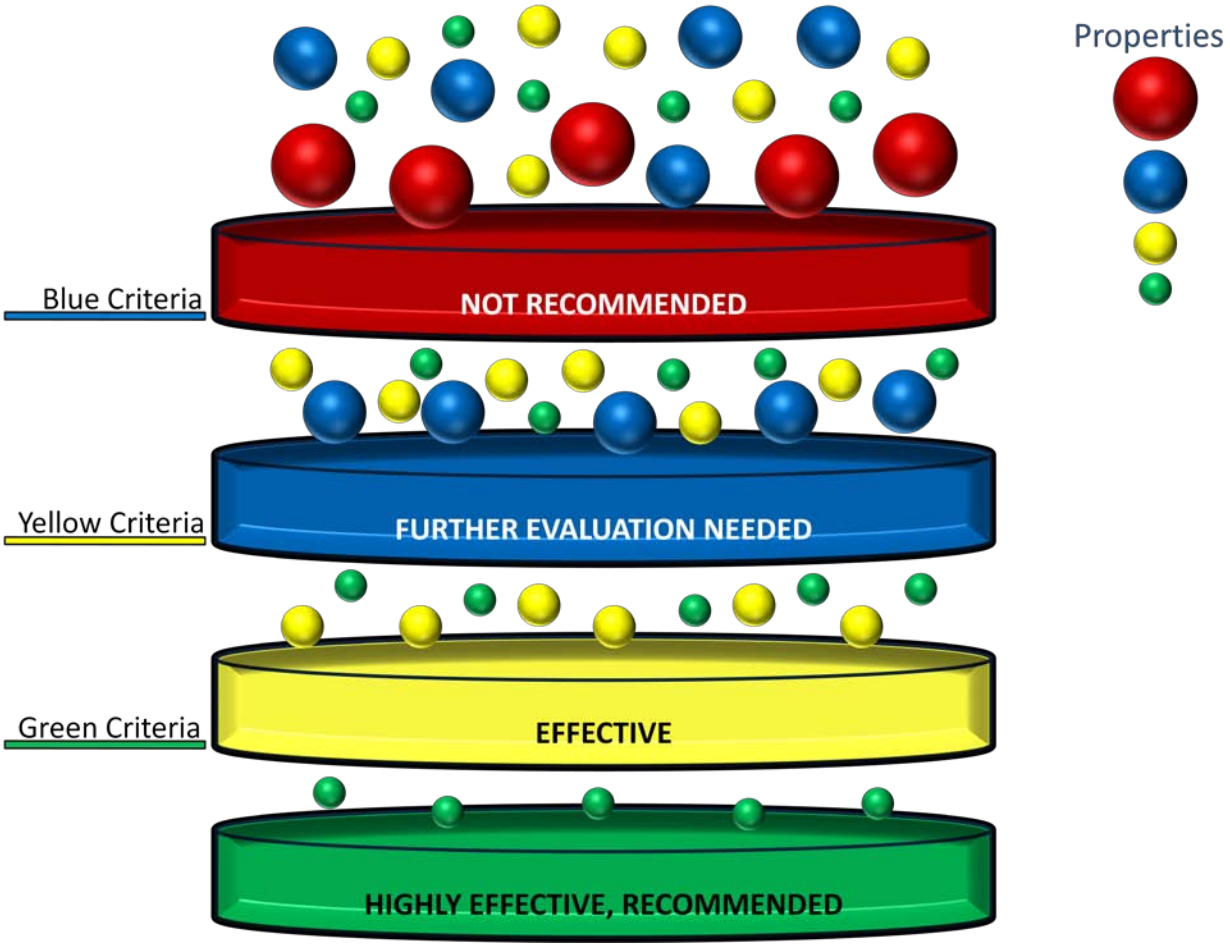


Figure 33: Sand Sifter Graphic

Section 4 Flood Mitigation Priority Scores

4.1 Purpose

The purpose of developing Flood Mitigation Priority Scores is to account for: (1) other community-based benefits and (2) other factors not included in the Flood Risk Property Score. The Flood Mitigation Scoring System will be used to generate ***Flood Mitigation Property Scores*** and ***Flood Mitigation Project Scores***. These scores will be used to prioritize individual properties and project areas. Prioritizing properties and projects will allow CMSWS various options when implementing capital improvement expenditures.

4.2 Flood Mitigation Scoring System

The Flood Mitigation Scoring System consists of 13 priority factors. Some of these factors are scored based on certain techniques being deemed "Effective" or "Highly Effective," while others are scored based on any technique. These factors and how they are scored are described in detail in the following sections.

4.2.1 Life and Human Safety

The life and human safety factor is applicable if the mitigation technique eliminates or significantly reduces the potential for "residual risk" and potential emergency response services. The criterion for this factor consists of whether or not the recommended technique(s) involve(s) the permanent removal of a habitable structure from the flood hazard area. This factor is scored based on the following techniques being deemed "Effective" or "Highly Effective."

- Property Acquisition and Structure Demolition
- Property Acquisition and Structure Relocation
- Property Acquisition, Demolition/Relocation, and Re-sale

4.2.2 Cost Effectiveness (Benefit-Cost Ratio)

This factor addresses the cost effectiveness of a mitigation project, which is based on a Benefit-Cost Ratio (BCR). BCRs are commonly used to determine cost effectiveness by comparing estimated benefits and costs. A project is considered cost effective when the estimated benefits equal or exceed the estimated costs. This results in a BCR ≥ 1.

FEMA's Benefit-Cost Analysis (BCA) Tool will be used to generate BCRs for this factor. The BCA Tool was developed by FEMA to serve as the standard method to evaluate and quantify the cost effectiveness of mitigation projects submitted for funding assistance under its hazard mitigation grant programs. In addition to confirming the required cost effectiveness criteria of proposed projects are met, the BCA Tool affords FEMA the ability to compare the value of mitigation projects competing against each other and to determine which the best alternatives are from a fiscal standpoint.

The methodologies, standard values and calculations included in the BCA Tool are continuously improved through routine software re-engineering and are commonly recognized as the industry standard for evaluating cost-effectiveness for mitigation project across the United States. However, it is also commonly noted that the BCA Tool's definition of benefits, which is limited to future losses prevented or reduced, is too narrow in scope and doesn't take into account additional benefits to society that are often realized at the local community level. These additional benefits include but are not limited to the additional community-based benefits considered in this plan's Flood Mitigation Scoring System (i.e., expanding or connecting publicly owned lands, greenway trails, sanitary sewer routes and water quality buffers). For this reason, CMSWS is limiting the emphasis and influence of the BCA Tool in its risk reduction recommendations and in the generation of Flood Mitigation Priority Scores.

Under this factor, the BCA Tool will be used to estimate benefits (i.e., flood losses avoided) of a mitigation project. The benefits estimated by FEMA's BCA software are based on FEMA's standard values for project useful life and are expressed as the present value of the expected avoided damages after the mitigation technique is implemented. The total project cost will be estimated outside of the BCA Tool using the County's tax data and building attribute information, in combination with cost assumptions. FEMA's standard values for project useful life and a summary of the cost assumptions are provided in **Appendix F**.

Points will be assigned based on the BCR generated using the estimated benefits and project costs as described above. A BCR $\geq$ 1.0 receives the highest number of points. A BCR ranging from 0.5 to 1.0 receives a mid-range point. A BCR < 0.5 receives no points. BCRs will be generated and scored for each property which has the following mitigation techniques deemed "Effective" or "Highly Effective."

- Property Acquisition and Structure Demolition
- Property Acquisition and Structure Relocation
- Property Acquisition, Demolition/Relocation, and Re-sale
- Structure Elevation
- Dry Floodproofing of Structures
- Wet Floodproofing of Structures

4.2.3 Proximity to Other Mitigation Projects

This factor recognizes enhancements to coordination and the possibility of reduced costs for holistic neighborhood solutions. This factor also accounts for efforts to minimize "checkerboard" approaches to flood mitigation and efforts to maximize potential for grouped property projects. Essentially, points are awarded if the project is located within 1,000 feet of other previously implemented or planned mitigation projects and has the following techniques being deemed "Effective" or "Highly Effective."

- Property Acquisition and Structure Demolition
- Structure Demolition and Rebuild
- Property Acquisition and Structure Relocation
- Property Acquisition, Demolition/Relocation, and Re-sale

- Structure Elevation

4.2.4 Property Added To Flood Zone

This factor addresses hardships caused by map changes to property owners who purchased a structure that was outside the mapped floodplain at the time of purchase. Points are awarded if the property is currently inside a mapped floodplain, but was not located in a mapped floodplain at the time of purchase by the current owner. This factor is scored based on any technique being deemed "Effective" or "Highly Effective."

4.2.5 Repetitive Loss Structure

This factor addresses recurring flood damages to insured structures. Properties are deemed Repetitive Loss (RL) or Severe Repetitive Loss (SRL) properties by FEMA based on the number and dollar amount of claims filed with the National Flood Insurance Program (NFIP). There is also a possibility that these structures may be eligible for multiple FEMA grant programs. Points are awarded if the structure is an SRL property, or an RL property. No points are awarded if the structure fails to meet one of these two criteria. This factor is scored based on any technique deemed "Effective" or "Highly Effective."

4.2.6 Property Adjacent To Publicly Owned Land

The purpose of this factor is to identify possible contiguous neighborhood project areas. Points are awarded if the property has at least one boundary in common with the property boundary of a parcel owned by a local, state, or Federal government entity. Since this factor involves creating contiguous neighborhood project areas, it is scored based on the following techniques being deemed "Effective" or "Highly Effective."

- Property Acquisition and Structure Demolition
- Property Acquisition and Structure Relocation
- Property Acquisition, Demolition/Relocation, and Re-sale

4.2.7 Property Located On Five-Year Planned Greenway Trail

This factor recognizes projects that achieve multiple community planning objectives and can maximize the use of funds by leveraging the project with another local government goal, in this case related to planned greenway trails. Points are awarded if the property is along stream sections which have been identified for a future greenway trail based on Park and Recreation's five-year plan. This factor is scored based on the following techniques being deemed "Effective" or "Highly Effective."

- Property Acquisition and Structure Demolition
- Property Acquisition and Structure Relocation
- Property Acquisition, Demolition/Relocation, and Re-sale

4.2.8 Property Located On Five-Year Planned Sanitary Sewer Route

This factor recognizes projects that achieve multiple community planning objectives and can maximize the use of funds by leveraging the project with another local government goal, in this case related to planned sanitary sewer routes. Points are awarded if the property is along a planned sanitary sewer alignment. This factor is scored based on the following techniques being deemed "Effective" or "Highly Effective."

- Property Acquisition and Structure Demolition
- Property Acquisition and Structure Relocation
- Property Acquisition, Demolition/Relocation, and Re-sale

4.2.9 Property Intersects With Water Quality Buffer

This factor recognizes projects that would positively impact water quality. Points are awarded if the property intersects a water quality buffer as defined by local Water Quality Ordinances. This factor is scored based on the following techniques being deemed "Effective" or "Highly Effective."

- Property Acquisition and Structure Demolition
- Property Acquisition and Structure Relocation

4.2.10 Property Located in an Environmental Focus Area

This factor recognizes projects that would positively impact water quality in one of the top ten (10) impacted watersheds, which are identified in the Water Quality Capital Improvement Project Watershed Ranking Protocol. Points are awarded if the property is located in one of these watersheds. This factor is scored based on the following techniques being deemed "Effective" or "Highly Effective."

- Property Acquisition and Structure Demolition
- Property Acquisition and Structure Relocation

4.2.11 Property Covered By NFIP Policy

This factor credits property owners who have taken action to reduce financial risk by having an active flood insurance policy under the NFIP. There is also a possibility that these structures may be eligible for multiple FEMA grant programs. Points are awarded if the property address is included in FEMA's NFIP policy database. This factor is scored based on any technique deemed "Effective" or "Highly Effective."

4.2.12 Historic Preservation and Cultural Asset Protection

Points are awarded if the project achieves multiple community objectives by protecting or enhancing historic or cultural assets. This is determined by whether the property includes historic

structure(s) or is in proximity to areas of historic or cultural significance. This factor is scored based on the following techniques being deemed "Effective" or "Highly Effective."

- Property Acquisition and Structure Relocation
- Structure Elevation
- Dry Floodproofing of Structures
- Wet Floodproofing of Structures

4.2.13 Other

The intent of this factor is to provide an opportunity to capture additional factors or unique considerations that should be taken into account. An example of this would be for properties on which owners have already taken flood mitigation action, such as elevating their HVAC. This factor will provide flexibility by allowing three levels of points that can be awarded (i.e., high, medium, or low). This factor is scored based on any technique deemed "Effective" or "Highly Effective."

4.3 Flood Mitigation Scores

The Flood Mitigation Scoring System will be used to generate Flood Mitigation Property Scores and Flood Mitigation Project Scores. The scoring factors, points, and applicable techniques are summarized in **Table 5**.

Table 5: Flood Mitigation Score Factors Summary

#	Priority Factor	Points	Criteria	Mitigation Techniques That Apply
1	Life and human safety	150	Project involves the permanent removal of habitable structure from flood hazard area	Property Acquisition and Structure Demolition Property Acquisition and Structure Relocation Property Acquisition, Demolition/Relocation, and Re-sale
2	Cost effectiveness (Benefit-Cost Ratio)	150 75 0	BCR $\geq$ 1.0 0.5 $\leq$ BCR < 1.0 BCR < 0.5	Property Acquisition and Structure Demolition Property Acquisition and Structure Relocation Property Acquisition, Demolition/Relocation, and Re-sale Structure Elevation Dry Floodproofing of Structures Wet Floodproofing of Structures
3	Proximity to other mitigation projects	125	Project is located within 1,000 feet of other previously implemented or planned mitigation projects	Property Acquisition and Structure Demolition Structure Demolition and Rebuild Property Acquisition and Structure Relocation Property Acquisition, Demolition/Relocation, and Re-sale Structure Elevation
4	Property added to flood zone	100	Property was not located in a mapped floodplain at the time of purchase by current owner	Any

#	Priority Factor	Points	Criteria	Mitigation Techniques That Apply
5	Repetitive loss structure	100 50 0	Severe Repetitive Loss Structure Repetitive Loss Structure N/A	Any
6	Property adjacent to publicly owned land	50	Property touches publicly owned land	Property Acquisition and Structure Demolition Property Acquisition and Structure Relocation Property Acquisition, Demolition/Relocation, and Re-sale
7	Property located on five-year planned greenway trail	50	Property intersects with five-year planned greenway trail	Property Acquisition and Structure Demolition Property Acquisition and Structure Relocation Property Acquisition, Demolition/Relocation, and Re-sale
8	Property located on five-year planned sanitary sewer route	50	Property intersects with five-year planned sanitary sewer route	Property Acquisition and Structure Demolition Property Acquisition and Structure Relocation Property Acquisition, Demolition/Relocation, and Re-sale
9	Property intersects with water quality buffer	50	Property intersects with County's comprehensive stream buffers	Property Acquisition and Structure Demolition Property Acquisition and Structure Relocation
10	Property located in an Environmental Focus Area	50	Property located in one of the County's top ten impacted watersheds	Property Acquisition and Structure Demolition Property Acquisition and Structure Relocation
11	Property covered by NFIP policy	30	Property address included in FEMA's NFIP policy database	Any
12	Historic preservation and cultural asset protection	30	Property includes historic structure(s) or is in proximity to areas of historic or cultural significance	Property Acquisition and Structure Relocation Structure Elevation Dry Floodproofing of Structures Wet Floodproofing of Structures
13	Other	150 100 50	High Medium Low	Any

4.3.1 Flood Mitigation Property Score

The Flood Mitigation Property Score is calculated first. Since there are some factors that are dependent upon certain techniques being deemed “Effective” or “Highly Effective, Recommended,” scores will be calculated for each of these techniques. The sum of these scores is the Flood Hazard Mitigation Score. The maximum Flood Hazard Mitigation Score possible is currently 1085 for techniques 1, 3, 4, 5, 7, and 8, but is 935 for all other techniques. This is because the “Cost Effectiveness” factor can only be calculated for techniques 1, 3, 4, 5, 7, and 8. The final Flood Hazard Mitigation Score that will be used to calculate the Flood Mitigation Property Score is the score resulting from the technique that generates the highest score.

In order to not overstate the importance of the Flood Hazard Mitigation Score versus flood risk, the final Flood Mitigation Property Score is not allowed to be more than 20% of the Flood Risk Property Score. Similar to other pieces of this plan, CMSWS reserves the right to adjust this 20%

cap in the future. The Flood Mitigation Property Score is calculated based on the following formula:

$$Flood\ Mitigation\ Property\ Score = Flood\ Risk\ Score \times \left[1 + \left(\frac{Flood\ Hazard\ Mitigation\ Score}{1085}\right) \times 0.2\right]$$

4.3.2 Flood Mitigation Project Score

Flood Mitigation Project Scores will be calculated in addition to Flood Mitigation Property Scores. There are many advantages to mitigating entire project areas. These include but are not limited to: cost savings, increased participation in mitigation, reduced emergency response services, and contiguous land for other community uses. Project areas will be created for the purpose of prioritizing and implementing more holistic and comprehensive mitigation strategy. The Flood Mitigation Project Scores will be calculated for each project area and will be used to prioritize projects. Prior to the automation of the Flood RA/RR Plan, CMSWS will delineate project areas. Available data will be used in establishing project areas: however, it will be a subjective process. The following criteria and guidelines will be used to define project areas.

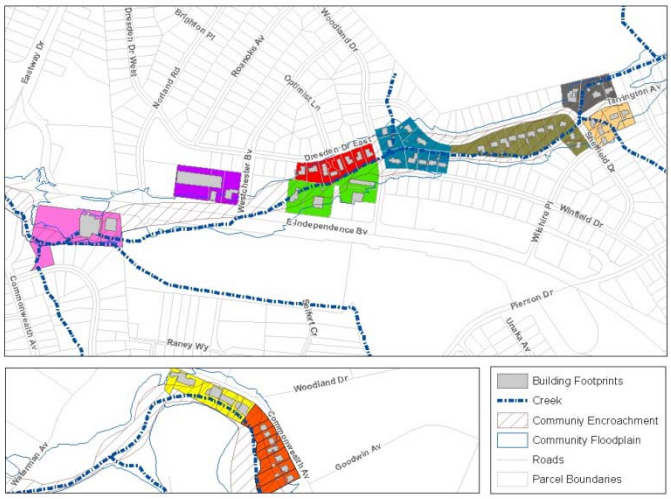


Figure 34: Example Project Area Map

<u>Project Area Identification</u>

Criteria:

- All properties must be contiguous to one another <u>or</u> other public property (parcels, roads, etc.)
- The Community Floodplain must touch the main structure to be included in a project area

Data to be used as general guidelines for grouping properties within the same project area:

- Same neighborhood
- Side of the creek
- Street geography
- Shared ingress/egress for emergency response
- Community Encroachment Area (new maps)
- 25-year floodplain (new maps)
- Similar building use (e.g., residential, commercial, multi-family, etc.)
- Tax values – Cumulative tax values can range between $0.5 to $1.5 million
- Number of parcels/buildings – Minimum of 2 buildings on same or contiguous parcels

Upon implementation, multiple project areas could be combined based on budget and potential to benefit additional properties. Project areas will be refined and adjusted if necessary to account for the following:

- Similar recommended mitigation techniques that would be relevant to defining project areas. These include:
    - Property Acquisition and Structure Demolition
    - Structure Demolition and Rebuild
    - Property Acquisition and Structure Relocation
    - Property Acquisition, Demolition/Relocation, and Resale
    - Structure Elevation
    - Storm Water Detention Facilities
    - Storm Water System Control
    - Levee/Floodwall Protection for Multiple Structures
- Flood Risk Property Scores
- Benefit-Cost Data
- High velocity Zones

Flood Mitigation Project Scores will be determined by averaging the Flood Mitigation Property Scores in the project area.

4.4 Applying the Flood Mitigation Scoring System

In order to explain the application of the Flood Mitigation Scoring System, an example calculation of the Flood Mitigation Property Score is as follows:

#	Priority Factors	Criteria Met	Points
1	Life and human safety	NO	0
2	Cost effectiveness (Benefit-Cost Ratio)	LOW	0
3	Proximity to other mitigation projects	YES	125
4	Property added to flood zone	NO	0
5	Repetitive Loss (RL) structure	N/A	0
6	Property adjacent to publicly owned land *	NO	0
7	Property located on five-year planned greenway trail *	NO	0
8	Property located on five-year planned sanitary sewer route *	NO	0
9	Property intersects with water quality buffer *	YES	50
10	Property located in an Environmental Focus Area *	NO	0
11	Property covered by NFIP policy	YES	30
12	Historic preservation and cultural asset protection	NO	0
13	Other	NA	0
	Flood Hazard Mitigation Score		**205**
	Mitigation Score Multiplier = 1+(155/1085) x 0.20		**1.04**
	Flood Risk Property Score		**451**
	Flood Mitigation Priority Score = 451 x 1.03		**468**

Section 5 Planning Process

5.1 Background

The process for developing the Flood RA/RR Plan began in 2009. It involved layers of review, assessment, and recommendations from a variety of sources. This multi-disciplinary approach was intended to broaden the perspective for the development of flood hazard mitigation strategies in Mecklenburg County. This approach included contributions by people with extensive flood mitigation experience and people with limited flood mitigation experience but extensive experience in other areas such as water quality and engineering. The staff involvement included CMSWS employees at various levels: project managers, supervisors, and a division manager. The final source of information included people from other areas that impact the floodplains such as park and recreation, utilities, and schools.

The process followed to develop this plan consisted of two phases. Phase I focused on developing a framework for the approach and Phase II focused on refining, finalizing, and applying the approach.

5.2 Phase I: Develop Framework

The first phase of this effort was to develop the framework for the approach and methodologies to be applied. Phase I tasks included assessing the flood risk by identifying the flooding circumstances that warrant increased mitigation effort, determining the flood mitigation techniques and strategies (both public and private mitigation actions) that are most effective in Mecklenburg County at reducing the flood risk, and developing criteria for applying the mitigation actions on a parcel or building level. Using a handyman analogy, Phase I of the update loaded the toolbox with the tools to complete the work, and provided the instruction books for which tools to use under which circumstances. The effectiveness of potential mitigation strategies were evaluated for use in Mecklenburg County. Selection criteria were developed to determine the flood mitigation techniques that provide the best results for a particular flood-prone property.

5.3 Phase II: Refine, Finalize, and Apply Methods

The second phase consisted of refining, finalizing, and applying the methods in Phase I. CMSWS worked with an experienced consultant (AECOM) to run a pilot study to refine and finalize the methodologies developed in Phase I. In addition to the pilot study, a Citizen Review Committee was established to assist in the review and improvement of the plan (see Section 5.4). Upon validating the results from the pilot study, the next step is to develop an automated tool that will apply the methodologies and criteria to recommend risk reduction actions and prioritize and guide CMSWS Capital Improvement expenditures into the future. This automated tool will allow CMSWS to update the Flood RA/RR Plan on a continual basis when new data becomes available.

5.4 Citizen Review Committee (CRC)

As part of Phase II, a Citizen Review Committee (CRC) was established. As the name implies, it was a citizen-based committee established to assist CMSWS in reviewing and improving the Flood RA/RR Plan. The overall purpose of the CRC was to review the new approach based on flood risk and provide input and feedback on the plan. The CRC was provided with updates on the Flood RA/RR Plan's progress.

The committee was comprised of 12 residents, all of which are owners of flood-prone residential properties. These 12 committee members represented seven different neighborhoods within three distinct watersheds (see **Figure 35**). Having the CRC in place and holding regular meetings ensured that the affected residents were part of the solution, which ultimately resulted in a better product. The CRC also fulfilled a vital role as a "sounding board" for the discussion of ideas and cross-checks to make sure that proposed thoughts, details, and approaches made good sense.

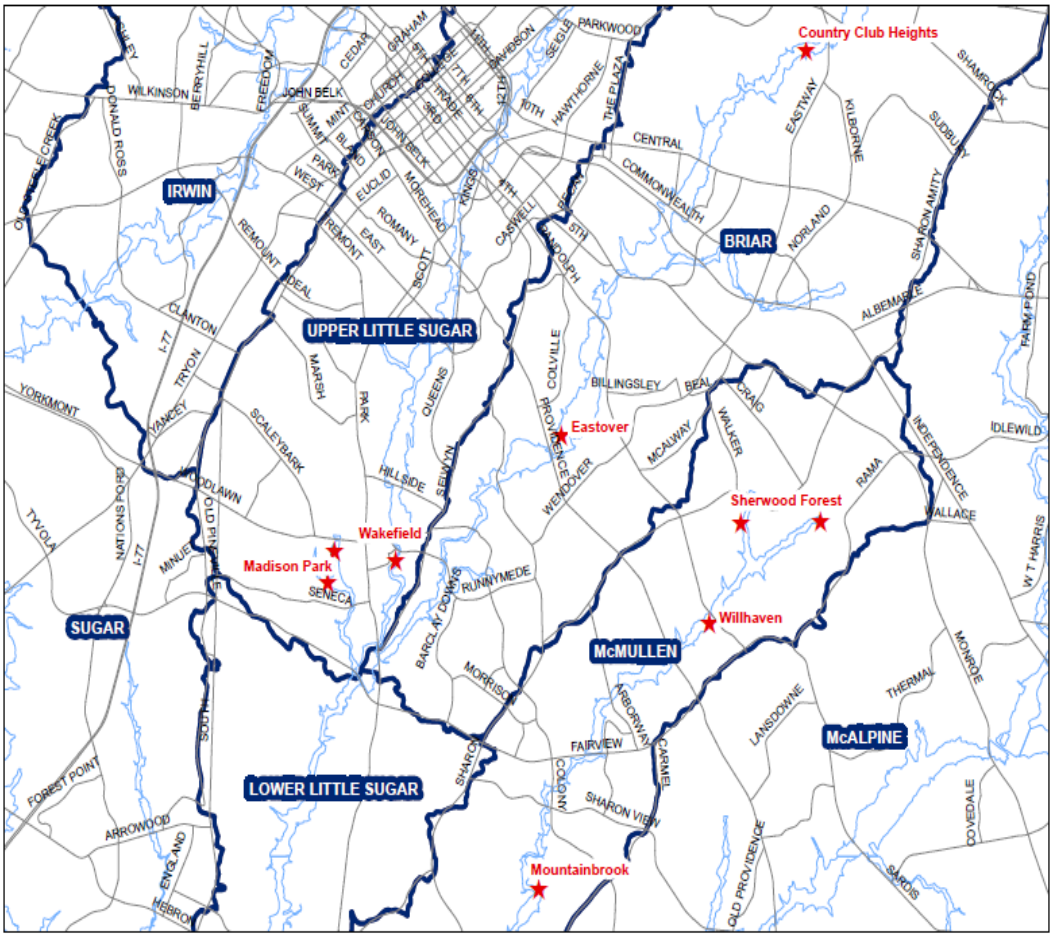


Figure 35: Neighborhoods and Watersheds Represented by CRC Members

5.4.1 CRC Meetings

There were nine CRC meetings held from February to November of 2011. **Table 6** provides a brief listing of these meetings along with the main topics covered. **Figure 36** shows a typical CRC meeting.

Table 6: CRC Meeting Schedule and Covered Topics

Meeting #	Date of Meeting	Main Topics Covered
1	February 16, 2011	Introduction of CRC members; purpose of the CRC; flood mitigation plan background
2	February 22, 2011	Introduction to flood risk; Flood Risk Property Score; pilot study areas and purpose
3	March 23, 2011	Flood risk factor comments; location factors; “money exercise”; vehicles
4	April 27, 2011	Flood Risk Property Scores; pilot study results; mitigation techniques concept overview; mitigation techniques
5	June 22, 2011	Mitigation techniques follow-up and discussion; Flood Mitigation Priority Score concept overview; Flood Mitigation Priority Score discussion
6	August 10, 2011	Mitigation techniques follow-up and discussion; Flood Mitigation Priority Score concept; Flood Mitigation Priority Score
7	September 28, 2011	Changes to mitigation techniques table; Flood Mitigation Priority Score walkthroughs; preliminary results of pilot study
8	October 26, 2011	Updated mitigation techniques table; Flood Mitigation Priority Score; project area criteria; conclusions from pilot study; group accomplishments; plan communication results
9	November 30, 2011	Communicating flood risk information; path forward; CRC member summary statement(s); wrap up and member recognition

Figure 36: CRC Meeting

5.4.2 CRC Input

The CRC provided input and feedback throughout the process. Specific topic areas where the CRC provided feedback included:

- Flood Risk Property Score
  - Flood impacts
  - Exterior property improvements
- Mitigation recommendations
  - Mitigation techniques
- Flood Mitigation Priority Score
  - Property factors

Feedback from the CRC also provided CMSWS with a "user" perspective.

5.5 Pilot Study

Two study areas were identified and used to test and refine the scoring methodologies developed in Phase I. The two study areas selected were the Edwards Branch study area which included 69 flood-prone properties and the Little Hope Creek study area which included 57 flood-prone properties (see **Figure 37**). Overall the pilot study area included a mix of residential and commercial structures, and a variety of individual building types within each category. The results of the pilot study were used to identify potential issues, such as data accuracy with regard to the flood models and building inventories, and to test and refine the process and methodology used.

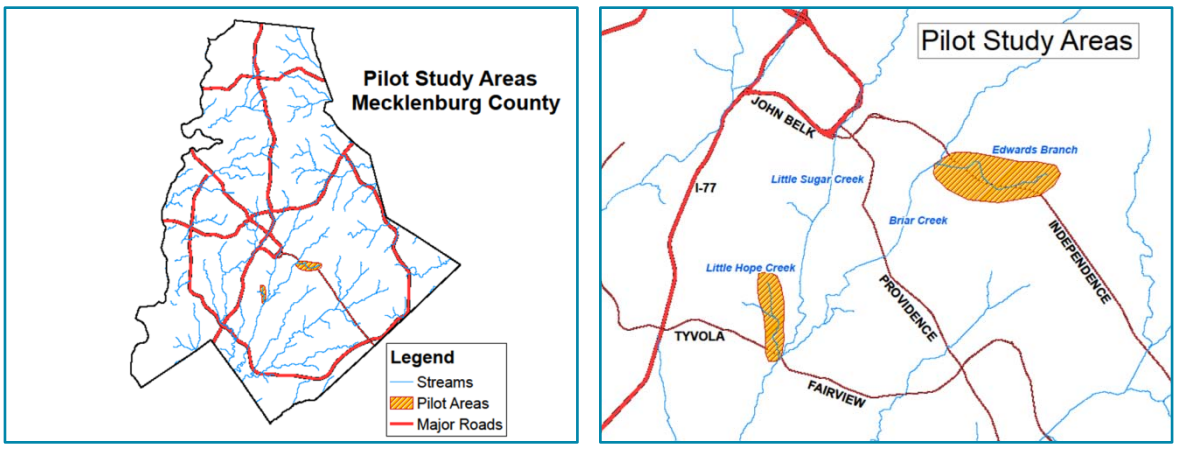


Figure 37: Map of Pilot Study Areas

5.5.1 Pilot Study Procedures

The first step in the pilot study was to acquire the best data available, including mapped flood hazard boundaries, parcel boundaries, building footprints, and elevation data. The second step was to identify and highlight high hazard zones based on potential flood depths and velocity. The proposed scoring methodologies from Phase I were then applied by AECOM through manual processing for each property. The manual processing consisted of assessing each property independently in GIS using aerial imagery, flood model data, building footprint data, Elevation Certificate (EC) information, and other County data layers. In addition, Benefit-Cost Ratios (BCRs) were determined for each property using FEMA BCA methodologies.

This plan consists of three steps: Flood Risk Property Score, Risk Reduction Recommendations, and Flood Mitigation Priority Score. Since the results from each step are used in the following step, the pilot study tested one step at a time. The results for each step were reviewed, assessed, and refined with CMSWS. The refined methodology was then used to re-score the properties and the results were finalized once they validated the changes.

The results, observations, and lessons learned for the Flood Risk Property Score, Risk Reduction Recommendations, and Flood Mitigation Priority Score are summarized in the following sections.

5.5.2 Flood Risk Property Score

A. Results

A template to calculate the Flood Risk Property Score was created in Microsoft Excel and applied to each property in the study area. An example of the template is shown in **Appendix G**. The scores were categorized into High (top 10%), Moderate (top 35%), and Low (remaining 65%) and shown on maps. Maps for the Little Hope Creek study area are shown in **Figure 38**.

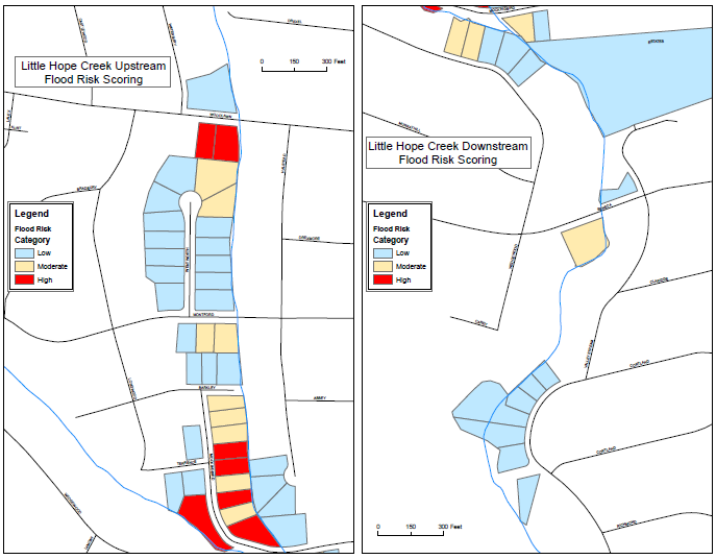


Figure 38: Map of Pilot Study Areas

These maps were used to determine if the results made sense based on CMSWS staff's knowledge of the areas' flooding history.

B. Observations

Based on the results, the following observations were made:

- Key indicators for high Flood Risk Property Scores included:
  - Criteria C (Flooding a Portion of Building)
  - Criteria E (Structure Completely Surrounded by Floodwater)
  - Flooding of Lowest Adjacent Grade (LAG)
- There is ***not*** a strong correlation between Location-based Factors (velocity or storm drain overflow) or Criteria A (First Floor Flooding) and high Flood Risk Property Scores
- Criteria I (Exterior Property Improvements) and Criteria J (Primary Parking Area)
  - Independently, these factors do not have a major influence on overall Flood Risk Property Score
  - These factors will influence risk classification (high, moderate, or low) for a small percentage of properties on the margins
  - Removal of both factors would result in significant point drops for moderate and low risk properties
  - Without consideration of these factors, properties that will move up in scoring will be multi-family and retail properties since they typically have no exterior improvements and do not receive scores for single family parking areas
- Key conclusions
  - Flood Risk Property Scores are driven heavily by flood frequency determinations
  - Flood Risk Property Scores are not being skewed by any specific flood impacts (first floor flooding, etc.)
  - Flood Risk Property Scores are not being skewed by location-based multipliers (e.g., velocity zones)

- Flood risk scoring appears reasonable and is achieving objectives of CMSWS

C. Lessons Learned

Two "lessons learned" were identified and are listed below:

- Flood risk scoring needed to better align with probability (i.e., frequency of flooding)
- High hazard zones needed to better reflect potential velocity of floodwaters, along with depth.
- In addition, one potential issue of concern was identified: initial Flood Risk Property Scores did not capture flooding problems related to storm drain overflows. An additional scoring factor was added to address this concern.

5.5.3 Risk Reduction Recommendations

A. Results

A template to evaluate the mitigation techniques was created in Microsoft Excel and applied to each property in the study area. This template captures detailed criteria for each mitigation technique, 1–18[2]. During the pilot study, the criteria that were met were highlighted in green. An example of the template is shown in **Appendix H.**

#	PROPERTY	RISK SCORE	MITIGATION TECHNIQUES 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
70	4339 WATERBURY DR	204																		
71	1224 WOODLAWN RD	564																		
72	1230 WOODLAWN RD	1846																		
73	4500 WENTWORTH PL	80																		
74	4501 WENTWORTH PL	451																		
75	4506 WENTWORTH PL	112																		
76	4507 WENTWORTH PL	369																		
77	4512 WENTWORTH PL	213																		
78	4515 WENTWORTH PL	221																		
79	4520 WENTWORTH PL	137																		
80	4521 WENTWORTH PL	133																		
81	4526 WENTWORTH PL	99																		
82	4527 WENTWORTH PL	83																		
83	4532 WENTWORTH PL	20																		
84	4533 WENTWORTH PL	105																		
85	4538 WENTWORTH PL	13																		
86	4539 WENTWORTH PL	263																		
87	1200 MONTFORD DR	85																		
88	1208 MONTFORD DR	335																		
89	1214 MONTFORD DR	303																		

	Highly Effective, Recommended
	Effective
	Further Evaluation Needed (Minimum Criteria)
	Not Recommended
	N/A (Incomplete Data)

Mitigation Techniques
1: Property Acquisition and Structure Demolition
2: Structure Demolition and Rebuild
3: Property Acquisition and Structure Relocation
4: Property Acquisition, Demolition or Relocation, and Re-sale
5: Structure Elevation
6: Dry Floodproofing of Structures
7: Wet Floodproofing of Structures
8: Audible Flood Warning System for Individual Property
9: Storm Water Detention Facilities
10: Storm Water System Control
11: Automated Flood Notifications
12: Public Education
13: Flood Insurance
14: Levee/Floodwall Protection for Multiple Structures
15: Protecting Service Equipment (HVAC, electrical, utilities, fuel)
16: Partial Dry Floodproofing
17: Partial Wet Floodproofing
18: Levee/Wall/Berm for a Single Structure

Figure 39: Example Dashboard

A "dashboard" in the form of an Excel spreadsheet was also created so that results from the pilot study could be viewed and compared "at-a-glance" in a graphical format (see **Figure 39**). This example shows that for each property a unique identifier was assigned, the physical street address is provided, the risk score is indicated, and a determination is color-coded in the boxes along that row for each mitigation technique evaluated in the pilot study (1–18)[3]. In the example, it is clear for each property which mitigation techniques were deemed "Highly Effective,

[3] At the time of the pilot study there were 18 mitigation techniques evaluated. The current plan now includes 19.

Recommended," "Effective," etc. (For more information on the mitigation techniques, refer to Section 3.2. For more information on the recommendation categories, refer to Section 3.3.)

Maps were also created for each mitigation technique based on the dashboard results in part to illustrate graphically how mitigation recommendations "make sense" relevant to one another spatially. For example, it is common to see groupings of similar determinations, such as a row of houses that are all deemed effective for property acquisition and structure demolition (see **Figure 40**). Viewing the pilot study results in this way also provided an opportunity for quality control and helped facilitate discussion of outliers (for example, one "Not Recommended" property in a cluster of "Highly Effective, Recommended" properties).

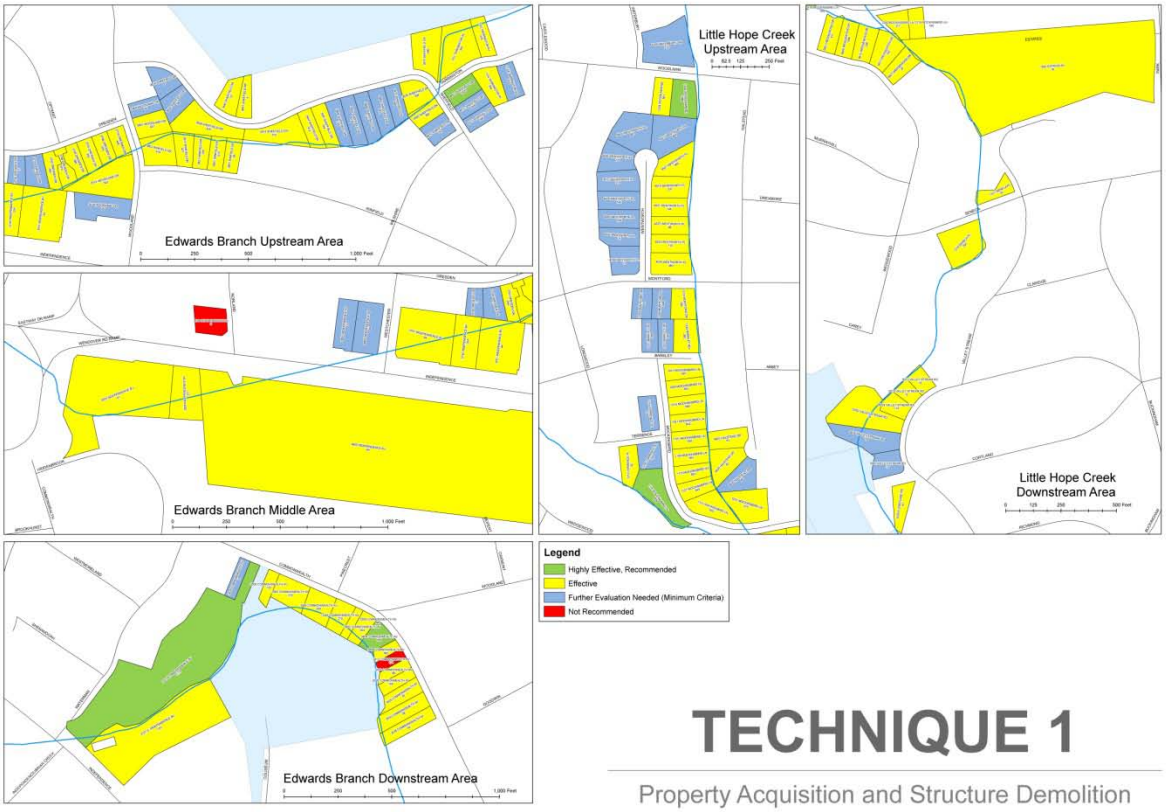


Figure 40: Example Dashboard Map

The example above shows pilot study results for mitigation technique 1, property acquisition and structure demolition. The Edwards Branch study area was broken down into three data views (above left) and the Little Hope Creek study area was broken down into two data views (above right).

B. Observations:

Based on the results, the following observations were made:

- Some mitigation techniques tended to be highly effective for most if not all properties; some techniques tended to be not recommended for a majority of the properties; some

techniques varied widely based on the physical and programmatic characteristics of the property in question
- The location of the structure (and sometimes the exact location of the structure on the parcel) can have a unique bearing on different mitigation techniques
    - For example, the structure's relationship to the floodplain, floodway, high velocity flood zones, water quality buffers, other publicly owned land, etc.
- Physical characteristics of the structure's construction can have a unique bearing on different mitigation techniques
    - For example, foundation type, wall type, building square footage, current elevation (and elevation of individual building components), etc.
- For many mitigation techniques, the presence of a basement (or details regarding the basement) is a key factor
    - Does the structure have a basement
    - Does the structure have a *finished* basement

C. Lessons Learned

The mitigation techniques criteria were revised numerous times to ensure the recommended techniques were appropriate for the properties in the pilot study. Five techniques were added during the pilot study, which are as follows:
- Protecting Service Equipment—Reduces flood risk to service equipment such as HVAC, electrical, mechanical, etc.
- Partial Dry Floodproofing—Reduces flood risk by protecting structures from smaller, more frequent flood events.
- Partial Wet Floodproofing—Reduces flood risk by protecting structures from smaller, more frequent flood events.
- Levee/Wall/Berm for a Single Structure—Reduces flood risk by protecting structures from smaller, more frequent flood events.
- Abandon Basement and Fill—This is an effective technique that is used in other parts of the country. It is not described in any of the other techniques.

5.4.5 Flood Mitigation Priority Score

A. Results

A template to calculate the Flood Risk Property Score was created in Excel and applied to each property in the study area. An example of the template is shown in **Appendix I**. The scores were categorized into High (top 10%), Moderate (top 35%), and Low (remaining 65%) and were compared to the Flood Risk Property Score. This was done to determine how much movement occurred in the results. The goal was to cap the mitigation multiplier such that it did not move a low risk property into the high risk category. Flood Mitigation Priority Scores were calculated using a 20%, 30%, 40%, and 50% cap. The properties were prioritized from highest to lowest based on the Flood Risk Property Score and the Flood Mitigation Priority Scores for each of the caps.

B. Observations

One observation on the scoring factors was on the criteria for the factor, "Proximity to other mitigation projects." This criterion was originally set at 2,000 feet. This was plotted on a map and was determined to be too large because it did not meet the purpose of the factor. Based on the map, this criterion was reduced to 1,000 feet.

Another observation was on the mitigation multiplier. This was set at 20% based on how much properties moved up or down the list. Due to the size of the pilot study, this percentage will be re-evaluated when the plan is automated and scores are generated for all flood-prone properties in the county. CMSWS will have the ability to evaluate and adjust this cap in the future to ensure that the intent of the Flood Mitigation Priority Score is met.

C. Lessons Learned

Lessons learned included the following:

- Flood Mitigation Priority Scores should not be allowed to overinflate the property's overall score. For the pilot study, setting the cap at 20% of the Flood Risk Property Score met this purpose. It should be noted that this cap need to be monitored and adjusted in the future.
- Care needed to be taken to ensure that the criteria for the Flood Mitigation Priority Score was fair, but did not create a situation where a low risk property became a high priority property. Several iterations of the pilot study mitigation scoring were completed using variations of the criteria to determine the appropriate combination of criteria and thresholds to achieve an appropriate Flood Mitigation Priority Score.
- In general, the flood mitigation scoring evolved throughout the pilot study process as factors and concepts were refined based on input from the CRC, AECOM, and CMSWS.

Section 6 Plan Maintenance

6.1 Plan Monitoring and Maintenance

One of the key features of this plan is that the results will reside in a digital environment. This will significantly extend the longevity and useful life of the Flood RA/RR Plan. The fundamental concepts contained within this plan document will continue to serve as the foundation of the plan, while the property specific plan results will change over time. These results, such as Flood Risk Property Scores, Risk Reduction Recommendations, and Flood Mitigation Priority Scores will be updated under two main circumstances:

1. ***Data changes or corrections*** to the supporting information occur that could result in changes to the property specific plan results.

2. ***Adjustments to computations*** are deemed necessary by staff to provide more accurate results.

A. Data Changes or Corrections

Each time data that feeds into the plan is changed or corrected, the property specific plan results could change. **Appendix B** contains data maintenance information for the major datasets utilized by this plan. The overall intent is for the plan to be a living, digital process and as such data and results will be updated on a continual basis. At a minimum, once per year, all the datasets will be reviewed for changes and if necessary, the plan results will be updated. For example, new data on a planned greenway could prompt an update to determine if the new information changes the extent to which properties meet, or fail to meet, criteria associated with planned greenways in the Flood Mitigation Priority Scoring step. In addition, staff may obtain more accurate property information (typically an Elevation Certificate) and elect to update the plan results for individual properties immediately.

B. Adjustments to computations

The Flood RA/RR Plan, has gone through extensive development, review, and vetting. However, it is a unique approach that has not been used in other communities. The Flood Risk Property Scores, Risk Reduction Recommendations, and Flood Mitigation Priority Scores need to be sound and reasonable. In the event staff determine changes to the computations, multipliers, weighting, etc. are necessary to provide more accurate results, adjustments will be made and documented.

6.2 Losses Avoided

The intent of the update process is for CMSWS to have the authority to make changes to the Flood RA/RR Plan without the need to return to the Mecklenburg County Board of County Commissioners to approve the changes. Examples of the types of changes CMSWS may wish to make to this plan over time include, but are not limited to, the following: point systems, multipliers, mitigation scoring caps, etc.

Appendix A: Acronyms and Definitions

This plan uses a number of terms, phrases, and acronyms that may have different meanings to different readers. The following is a list of terms and definitions that may be useful in understanding key concepts of this document.

Base Flood: A flood having a 1% chance of being equaled or exceeded in any given year.

Base Flood Elevation: The elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year. The BFE is shown on the Flood Insurance Rate Map (FIRM) for zones AE, AH, A1–A30, AR, AR/A, AR/AE, AR/A1– A30, AR/AH, AR/AO, V1–V30, and VE.

Basement: Any area of the building, having its floor subgrade (below ground level on all sides).

BCA: Benefit-Cost Analysis

BCR: Benefit-Cost Ratio

Building: Any structure built for support, shelter, or enclosure for any occupancy or storage.

CIP: Capital Improvement Program

CMEMO: Charlotte-Mecklenburg Emergency Management Office

CMSWS: Charlotte-Mecklenburg Storm Water Services

Community Base Flood: The flood determined using future land use conditions having a 1% chance of being equaled or exceeded in any given year.

Community Base Flood Elevation: The elevation shown on the Flood Insurance Rate Map Flood Hazard Data Table, having a 1% chance of being equaled or exceeded, determined using future land use conditions.

Community Development Block Grant: The Community Development Block Grant (CDBG) program is a flexible program that provides communities with resources to address a wide range of unique community development needs. Beginning in 1974, the CDBG program is one of the longest continuously run programs at HUD. The CDBG program provides annual grants on a formula basis to 1209 general units of local government and States.

Community Encroachment Area: The channel of a stream or other watercourse and the adjacent land areas that must be reserved in order to discharge the FEMA Base Flood without cumulatively increasing the water surface elevation more than 0.1 foot.

Community Floodplain: This shows where flooding is likely to occur in the future, based on expected development upstream.

CRC: Citizen Review Committee

FEMA: Federal Emergency Management Agency

FEMA Base Flood: The flood determined using land use conditions at the time of the study having a 1% chance of being equaled or exceeded in any given year.

FEMA Base Flood Elevation (BFE): The elevation shown on the Flood Insurance Rate Map and Flood Insurance Study Profile that indicates the water surface elevation resulting from a FEMA Base Flood that has a 1% chance of equaling or exceeding that level in any given year.

FEMA Floodway: The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the FEMA Base Flood, without cumulatively increasing the water surface elevation more than 0.5 foot. On the Catawba River, and the portions of Six Mile Creek and Rocky River which run along the county boundary line, the FEMA Floodway means the channel of a stream or other watercourse and the adjacent land areas that must be reserved in order to discharge the FEMA Base Flood, without cumulatively increasing the water surface elevation more than 1.0 feet.

First Floor Elevation (FFE): This is the elevation of the top of the lowest finished floor of the structure being studied. Also referred to as Finished Floor Elevation.

Flood or Flooding: A general and temporary condition of partial or complete inundation of normally dry land areas from:

1. The overflow of inland or tidal waters; and/or
2. The unusual and rapid accumulation of run-off of surface waters from any source.

Flood Information & Notification System (FINS): A network of automated rain and stream gages that constantly measure precipitation and stream depth in target streams where flooding has resulted in risk to people and damage to structures in the past.

Flood Insurance Rate Map (FIRM): An official map of a community, in both digital and printed format, on which the Federal Emergency Management Agency has delineated the Special Flood Hazard Area and the risk premium zones applicable to the community. The date of Charlotte's original FIRM is August 15, 1978 and this date should be used to determine whether a structure is pre-FIRM or post-FIRM.

Flood Insurance Study (FIS): A compilation and presentation of flood risk data for specific watercourses, lakes, and coastal flood hazard areas within a community. When a flood study is completed for the NFIP, the information and maps are assembled into an FIS. The FIS report contains detailed flood elevation data in flood profiles and data tables.

Flood Mitigation: Action(s) taken to reduce or eliminate long-term risk to life and property from a flood event.

Flood Mitigation Plan: A plan that identifies flood risks and mitigation actions to reduce or eliminate long-term risk to life and property from flooding.

Flood Protection Elevation (FPE): The elevation to which all structures located within the Community Special Flood Hazard Area must be elevated (or floodproofed if non-residential). Within areas where Base Flood Elevations (BFEs) have been determined, this elevation shall be the Community Base Flood Elevation plus one (1) foot of freeboard (except along the Catawba River where it is the FEMA Base Flood Elevation plus two (2) feet of freeboard). In areas where no BFE has been established, all structures and other development must be elevated (or floodproofed if non-residential), to two (2) feet above the highest adjacent grade. For the purposes of this plan, this will be based on the Community Base Flood Elevation plus one (1) foot of freeboard.

Flood Risk: The likelihood of impacts/consequences (financial, personal, and property damage) resulting from a flood.

Floodplain: Any land area susceptible to being inundated by flood waters from any source.

Floodproofing: Any combination of structural and nonstructural additions, changes, or adjustments to structures, which reduce or eliminate risk of flood damage to real estate or improved real property, water and sanitation facilities, or structures with their contents.

Floodway: Is either the FEMA Floodway or the Community Encroachment Area.

Freeboard: The height added to the Community Base Flood Elevation (BFE) to account for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, blockage of bridge openings, and the hydrological effect of urbanization of the watershed. The Community Base Flood Elevation (BFE) plus the freeboard establishes the "Flood Protection Elevation."

Historic Structure: Any structure that is:

1. listed individually in the National Register of Historic Places (a listing maintained by the U.S. Department of Interior) or preliminarily determined by the Secretary of Interior as meeting the requirements for individual listing on the National Register;
2. certified or preliminarily determined by the Secretary of Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district
3. individually listed on a local inventory of historic landmarks in communities with a Certified Local Government (CLG) Program"; or
4. certified as contributing to the historical significance of a historic district designated by a community with a "Certified Local Government (CLG) Program"

Increased Cost of Compliance (ICC): The National Flood Insurance Program (NFIP) includes this coverage for all new and renewed Standard Flood Insurance Policies. Policyholders can get

up to $30,000 to help pay the costs to bring their home or business into compliance with their community's floodplain ordinance.

Lowest Floor: The lowest floor of the lowest enclosed area (including the basement). An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area, is not considered a building's Lowest Floor provided that such enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirements of this ordinance.

Lowest Mechanical Equipment (LME): The lowest elevation height of mechanical and/or electrical equipment, such as air conditioners, furnaces, hot water heater, etc.

Lowest Adjacent Grade: The elevation of the ground, sidewalk, or patio slab immediately next to a building.

NFIP: National Flood Insurance Program

Post-FIRM: A building that was constructed after August 15, 1978.

Pre-FIRM: A building that was constructed before August 15, 1978.

Repetitive Loss: Flood-related damages sustained by a structure on two (2) separate occasions during any 10-year period for which the cost of repairs at the time of each such flood event, on the average, equals or exceeds 25% of the Market Value of the structure before the damage occurred.

Severe Repetitive Loss (SRL): A residential property that is covered under an NFIP flood insurance policy and: (a) that has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or (b) for which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. For both (a) and (b), at least two of the referenced claims must have occurred within any 10-year period, and must be greater than 10 days apart.

Special Flood Hazard Area (SFHA): The 100-year, or 1-percent-annual-chance, flood zone.

Appendix B: Data Requirements

This Plan requires an abundance of data that is found in various sources. The data sources are listed below with information on the maintenance schedule and the data provided.

- **Elevation Certificate Database:** *This data is updated regularly as new Elevation Certificates are received.*
  - Street address
  - Lowest Finished Floor Elevation (FFE)
  - Lowest Mechanical Elevation (LME)
  - Lowest Adjacent Grade (LAG)
  - Highest Adjacent Grade (HAG)
  - Water surface elevations (WSELs) for 2-, 5-, 10-, 25-, 50-, 100-, and 500-year modeled storms
  - WSEL for 100-year future event (community floodplain)
  - Basement information
  - Foundation information

- **Parcel Database:** *This data is updated regularly as data changes.*
  - Parcel ID
  - Address
  - Occupancy type
  - Foundation
  - Number of Units
  - Date of Last Sale
  - Year Built
  - Total Value
  - Land Value
  - Building Grade
  - Number of Stories
  - Exterior Wall
  - Heated Square Feet
  - Foundation Type

- **Building Footprints:** *Updated as needed.*

- **Bed Elevations:** *Updated when FIRM is updated.*

- **Floodplain Maps:** *Updated when FIRM is updated.*

- **Community Encroachment Area:** *Updated when FIRM is updated.*

- **Critical Facilities:** *Updated as needed.*

- **Water Quality Buffer:** *Updated as needed.*

- **Local and National Historic Sites:** *Updated as needed.*
- **5-year Water CIP:** *Updated as needed.*
- **5-year Sewer CIP:** *Updated as needed.*
- **5-year Greenway:** *Updated as needed.*
- **Parks:** *Updated as needed.*
- **Parking Locations:** *Updated as needed.*
- **High Danger Depth-Velocity Areas:** *Updated each time new models are developed.*
- **Moderate Danger Depth-Velocity Areas:** *Updated each time new models are developed.*
- **Water Quality CIP Sites:** *Updated as needed.*
- **Significant Property Improvements:** *Updated as needed; could be updated upon request of property owner*.
- **Moderate Property Improvements:** *Updated as needed; could be updated upon request of property owner.*
- **Public Lands:** *Updated as needed.*
- **Mitigation Projects:** *Updated monthly*.
- **Repetitive Losses:** *Updated yearly.*
- **NFIP Policies:** *Updated yearly.*
- **Environmental Focus Areas:** *Updated as needed.*

Appendix C: Documentation (of Decisions and Assumptions Made)

Item/Issue	Explanation of Decision(s) Made
Property improvements such as sheds, garages, swimming pools, etc. are not accounted for in the Flood Risk Property Score.	Significant and moderate exterior property improvements were added as flood risk factors. Guidelines were developed to identify improvements that were functional necessities to the property.
Parked vehicles should be accounted for as a flood impact because in many situations, flooding occurs overnight and residents are unaware of rising flood waters. Data for this factor will have to be manually developed.	This factor was added for single-family residential homes. Vehicles parked around non-residential buildings typically can be moved because occupants are nearby and awake while buildings are in use. Vehicles parked around multi-family buildings were not included because of the difficulty in determining the location of residents parked. During the pilot study, this factor was evaluated and verified that it did not heavily impact Flood Risk Property Scores.
How were the Flood Risk Property Score thresholds determined for the purposes of flood mitigation scoring? (i.e., ≥ 300, ≥ 500, and ≥ 700)	The thresholds were developed based on the distribution of the pilot study results. These thresholds will be re-evaluated and adjusted in the future to ensure they are based on the distribution of Flood Risk Property Scores.
How were the building tax value thresholds determined for the purposes of flood mitigation scoring? (i.e., ≥ $30,000, ≤ $30,000, etc.)	$30,000 is what the ICC program provides for elevations and is a typical low end cost to elevate a 1,000+ sq. ft. ranch house.
How were the structure footprint thresholds determined for the purposes of flood mitigation scoring? (i.e., ≤ 2,000 sf and ≤ 1,500 sf)	The thresholds were developed to account for project costs. The larger the footprint, the more difficult and costly it is to relocate the structure. 2,000 sf is an average area for a single-family home.
How was the maximum elevation height of 9 feet determined for the Structure Elevation mitigation technique?	FEMA P-312
How were the Base Points determined for the Flood Risk Scoring System?	They were determined from subjectively combining the CRC Rating and Average Damage Rating.

Appendix D: Flood Risk Property Score – Impact-based Scoring Matrix

						Storm Event Recurrence Interval ←←← More frequent (closest to the creek) ←←← →→→ Less frequent (further from the creek) →→→						
	Property Flood Impacts	**CRC Rating**	**Estimated Ave. Damage**[1]	**Ave. Damage Rating**	**Rating Base Points**[2]	**2-year** *(50% annual chance)*	**5-year** *(20% annual chance)*	**10-year** *(10% annual chance)*	**25-year** *(4% annual chance)*	**50-year** *(2% annual chance)*	**100-year** *(1% annual chance)*	**500-year** *(.2% annual chance)*
A	Flooding above the lowest finished floor of a building	27.3%	$35,000	29.0%	2800	1400	560	280	112	56	28	6
B	Flooding of electrical and/or mechanical equipment	15.6%	$10,000	8.3%	1200	600	240	120	48	24	12	2
C	Flood water is touching a portion of the building	15.2%	$5,000	4.1%	1000	500	200	100	40	20	10	2
D	Property is completely surrounded by flood water (ingress/egress off of flooded property)	13.0%	$10,000	8.3%	1100	550	220	110	44	22	11	2
E	Structure is completely surrounded by flood water (ingress/egress from building)	7.8%	$3,000	2.5%	500	250	100	50	20	10	5	1
F	Structure is completely surrounded by flood water AND is a Critical Facility	-	$18,000	-	2700	1350	540	270	108	54	27	5
G	Structure is completely surrounded by flood water AND is multi-family residential	-	$12,000	-	1400	700 x [# units-1]	280 x [# units-1]	140 x [# units-1]	56 x [# units-1]	28 x [# units-1]	14 x [# units-1]	3 x [# units-1]
H	Flood water is touching a portion of the building AND has structural damage as a result of cumulative flooding	11.8%	$40,000	33.2%	2000	1000	400	200	80	40	20	4
I1	Flooding of SIGNIFICANT exterior property improvements	5.0%	$6,000	5.0%	600	N/A	N/A	60	N/A	12	6	N/A
I2	Flooding of MODERATE exterior property improvements		$3,000	2.5%	300	N/A	N/A	30	N/A	6	3	N/A
J	Flooding around area where single-family residential vehicles are typically parked	4.2%	$8,000	6.6%	600	N/A	N/A	60	N/A	12	6	N/A
K	Flooding of any yard (any portion of parcel)	0.2%	$500	0.4%	30	15	6	3	1	1	0	0

[1]Assumptions

- Estimated Damage assumed to median home value in Charlotte ~ $200,000
- Damage is significant, but not a total loss
- Estimates assume some basic level of emergency service (if applicable) and some cost associated with human loss
- From USACE depth-damage curves - Ave damage below FFE - $13,000, 4 ft into FFE ~ $35,000
- F doubles to order of magnitude due to critical facility = (B+C+E)
- G accounts for additional equipment, people and vehicles due to multi-family = (1/2B+E+1/2J)
- According to the Bureau of Transportation Statistics the average value for a used vehicle in the U.S. is ~ $8,000
- Assume two vehicles per single family residence, damaged at 50% of average value

[2]Rating Base Points – Determined from subjectively combining the CRC Rating and Ave. Damage Rating

Note: The point system shown in the preceding table may change over time as CMSWS monitors and evaluates this plan and its processes.

Appendix E: Mitigation Techniques Criteria Summary

	Technique	Further Evaluation Needed (Minimum Criteria)	Effective	Highly Effective, Recommended
1	**Property Acquisition and Structure Demolition (BUYOUT)**	1 Structure is pre-FIRM **OR** Structure is post-FIRM and has finished floor elevation lower than the Flood Protection Elevation	1 Property is located adjacent to publicly owned land **OR**	1 Property is located at potential water quality capital improvement site **OR**
		2 Property has Risk Score ≥ 300 **OR**	2 Any part of the structure is located inside a water quality buffer **OR**	2 Property is located in critical needs area of planned greenway, park, sanitary sewer line, or water line **OR**
			3 Property has Risk Score ≥ 500 **OR**	3 Property has Risk Score ≥700 **OR**
2	**Structure Demolition and Rebuild (DEMO REBUILD)**	1 Land area outside the FEMA Floodway is large enough to accommodate 1.5x the footprint of the structure (to account for setbacks) **AND**	1 Land area outside the water quality buffer is large enough to accommodate 1.5x the footprint of the structure **AND**	1 Property is not surrounded by water during the FEMA Base Flood **AND**
		2 Land area outside the high velocity zone is 1.5x the footprint of the structure **AND**	2 Building tax value is ≤$30,000 **OR**	2 Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line **OR**
			3 Building grade is Below Average **OR**	3 Property is not located at a potential water quality capital improvement site **OR**
			4 Land tax value is ≥ 3x the building tax value **OR**	
3	**Property Acquisition and Structure Relocation (RELOCATION)**	1 Structure is pre-FIRM **OR** Structure is post-FIRM and has finished floor elevation lower than the Flood Protection Elevation	1 Structure is a single story (no split levels or multi-story). **AND**	1 Structure footprint is ≤1500 sf **OR**
		2 Structure foundation is not slab-on-grade **AND**	2 Structure footprint is ≤2000 sf. **AND**	2 Property is located in critical needs area of planned greenway, park, sanitary sewer line, or water line **OR**
		3 Structure **does not have masonry walls** **AND**	3 Property is located adjacent to publicly owned land **OR**	3 Property is located at a potential water quality capital improvement site **OR**
		4 Building tax value is >$30,000 **AND**	4 Any part of the structure is located inside a water quality buffer **OR**	4 Property has Risk Score ≥700 **OR**
		5 Property has Risk Score ≥ 300 **OR**	5 Property has Risk Score ≥ 500 **OR**	

	Technique	Further Evaluation Needed (Minimum Criteria)	Effective	Highly Effective, Recommended
4	**Property Acquisition, Demolition or Relocation, and Re-sale (BUYOUT RE-SALE)**	1 Structure is pre-FIRM **OR** Structure is post-FIRM and has finished floor elevation lower than the Flood Protection Elevation	1 Property is located adjacent to publicly owned land **OR**	1 Property is located in critical needs area of planned greenway, park, sanitary sewer line, or water line **OR**
		2 Resale portion of property outside the Community Encroachment Area is ≥1 acre for commercial, industrial or retail zoned property or ≥½ acre for residential zoned property **AND**	2 Any part of the structure is located inside a water quality buffer **OR**	2 Property is located at a potential water quality capital improvement site **OR**
		3 Property has Risk Score ≥ 300 **OR**	3 Property has Risk Score ≥ 500 **OR**	3 Property has Risk Score ≥700 **OR**
5	**Structure Elevation (ELEVATION)**	1 Structure is not located in an area with high-velocity flows **AND**	1 Structure is located outside any water quality buffer **AND**	1 Structure is not surrounded by flood water during the FEMA Base Flood **AND**
		2 Structure is outside the FEMA Floodway **AND**	2 Property is not surrounded by water during the FEMA Base Flood **AND**	2 Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line **OR**
		3 Structure is not a split-level **AND**	3 Structure foundation is not slab-on-grade **AND**	3 Property is not located at a potential water quality capital improvement site **OR**
		4 Elevation height is 0-9 ft. (FPE - FFE = 0-9 ft.) **AND**	4 Building tax value is >$30,000 **OR**	
			5 Building grade is Average, Good, Very Good, Excellent, or Custom **OR**	
			6 Land tax value is < 3x the building tax value **OR**	
6	**Abandon Basement and Fill (FILL BASEMENT)**	1 Structure is not located in an area with high-velocity flows **AND**	1 Structures is located outside any water quality buffer **AND**	1 Structure is not surrounded by flood water during the FEMA Base Flood **AND**
		2 Structure is outside the FEMA Floodway **AND**	2 Property is not surrounded by water during the FEMA Base Flood **AND**	2 Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line **OR**
		3 Structure has a basement **AND**		3 Property is not located at a potential water quality capital improvement site **OR**
		4 Next Higher Floor is ≥ Flood Protection Elevation **AND**		

	Technique	Further Evaluation Needed (Minimum Criteria)		Effective		Highly Effective, Recommended	
7	**Dry Floodproofing of Structures (DRY FLOODPROOFING)**	1 Residential Pre-FIRM - Lowest Floor is not necessarily above the FPE Residential Post-FIRM - Lowest Floor is above the FPE	**OR** Non-Residential Pre- and Post-FIRM	1 Structure is not surrounded by flood water during the FEMA Base Flood	**AND**	1 Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line	**OR**
		2 Top of foundation wall is ≤3 ft above adjacent grade	**AND**	2 Structure is located outside any water quality buffer	**AND**	2 Property is not located at a potential water quality capital improvement site	**OR**
		3 Flood depths are ≤3 ft	**AND**				
		4 Structure does not have a basement	**AND**				
		5 Structure **has masonry or masonry veneer type** walls	**AND**				
		6 Structure is not located in an area with high-velocity flows	**AND**				
		7 Structure is located outside the FEMA Floodway	**AND**				
8	**Wet Floodproofing of Structures (WET FLOODPROOFING)**	1 Structure foundation is not slab-on-grade	**AND**	1 Structure is surrounded by flood water during the FEMA Base Flood	**AND**	1 Structure is located outside the Community Encroachment Area	**AND**
		2 Structures does not have a finished basement	**AND**	2 Structure is located outside any water quality buffer	**AND**	2 Any part of the structure is located within the FEMA floodplain	**AND**
		3 FEMA Base Flood Elevation is <8 ft above the Lowest Floor (basement) or LAG(crawlspace)	**AND**			3 Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line	**OR**
		4 Finished Floor Elevation is higher than FEMA Base Flood Elevation	**AND**			4 Property is not located at a potential water quality capital improvement site	**OR**
		5 Structure is not located in an area with high-velocity flows	**AND**				
		6 Structure is located outside the FEMA floodway	**AND**				
9	**Audible Flood Warning System for Individual Property (AUDIBLE WARNING)**			1 Any part of the property is located in the Community Floodplain.	**AND**	1 Any part of the structure is within a high-velocity zone	**OR**
				2 The Lowest Adjacent Grade to the structure is below the Community Base Flood Elevation	**AND**	2 Any part of the structure is within the 25-year floodplain	**OR**

	Technique	Further Evaluation Needed (Minimum Criteria)	Effective	Highly Effective, Recommended
10	**Storm Water Detention Facilities (DETENTION)**	1 Potential detention area is located in a City of Charlotte Storm Water Services priority watershed **AND** 2 Approximately 4 acres or more of storage space per 1 square mile of drainage area **AND** 3 Approximately 30% or more of proposed area for detention basins must be publicly owned land **AND** 4 Approximately 100 structures or more with potential flood damage reduction within 2 miles downstream of the detention basin – the closer the structures are to the basin, the greater the impact required to warrant further investigation **AND**		
11	**Storm Water System Control (FLOOD CONTROL)**	1 Backwater upstream of bridge or culvert impacts approximately 25 structures **AND** 2 The road overtopping height to culvert opening height ratio is > 2 **AND** 3 Internal staff review process identifies this culvert as a concern **AND**		
12	**Automated Flood Notifications (FINS NOTIFICATION)**			1 Any part of the property is located in the Community Floodplain.
13	**Public Education (PUBLIC EDUCATION)**			1 Any part of the property is located in the Community Floodplain.
14	**Flood Insurance (FLOOD INSURANCE)**			1 Any part of the property is located in the Community Floodplain.

	Technique	Further Evaluation Needed (Minimum Criteria)	Effective	Highly Effective, Recommended
15	**Levee/Floodwall Protection for Multiple Structures (LEVEE)**	1 Property where levee/floodwall will be constructed is not located in a critical needs area of planned greenway, park, sanitary sewer line, or water line **AND**		
		2 Property where levee/floodwall will be constructed is not located at a potential water quality capital improvement site **AND**		
		3 Levee/Floodwall will be located outside the FEMA Floodway **AND**		
		4 Proposed levee/floodwall would protect Habitable Buildings from flooding above the Lowest Floor during the Community Base Flood Event **AND**		
		5 Levee/floodwall must be located on land that is not owned by a government entity **AND**		
		6 Levee/floodwall must comply with local, state and federal requirements **AND**		
		7 Property where levee/floodwall will be constructed is not located adjacent to publicly owned land **AND**		
		8 Levee/floodwall will be located outside any water quality buffer **AND**		
16	**Protecting Service Equipment (PROTECTING EQUIPMENT)**		1 Service equipment elevation is below the FEMA Base Flood Elevation	1 FFE of main structure is above the FEMA Base Flood Elevation **AND**
				2 Structure is located outside the FEMA Floodway **AND**
17	**Partial Dry Floodproofing (PARTIAL DRY FLOODPROOFING)**	1 Structure does not have a basement **AND**		
		2 Structure **has masonry or masonry veneer type** walls **AND**		
		3 Structure is not located in an area with high-velocity flows **AND**		
		4 Structure is located outside the FEMA floodway **AND**		

	Technique	Further Evaluation Needed (Minimum Criteria)	Effective	Highly Effective, Recommended
18	**Partial Wet Floodproofing (PARTIAL WET FLOODPROOFING)**	1 Structure foundation is not slab-on-grade **AND**		
		2 Structures does not have a finished basement **AND**		
		3 Structure is not located in an area with high-velocity flows **AND**		
		4 Structure is located outside the FEMA floodway **AND**		
19	**Levee/Wall/Berm for a Single Structure (RING LEVEE)**	1 Structure is located outside the Community Encroachment Area **AND**		
		2 Structure is not surrounded by flood water during the FEMA Base Flood **AND**		
		3 Structure is located outside any water quality buffer **AND**		
		4 Structure is not located in an area with high-velocity flows **AND**		

Appendix F: Benefit-Cost Assumptions

Effective Useful Life for Calculation of Benefits

Technique	Effective Useful Life (years)
Property Acquisition and Structure Demolition	100
Property Acquisition and Structure Relocation	100
Property Acquisition, Demolition/Relocation, and Resale	100
Structure Elevation	30
Dry Floodproofing	30
Wet Floodproofing	15

Cost Assumptions

Property Acquisition and Structure Demolition

Structure Type	Purchase Price	Soft Costs	Demolition Cost*	Project Management Cost
Residential	*Tax Value x Multiplier*	$4100/Unit	$10 / Square Foot of Building Area	5%
Commercial		$7000	$6 / Square Foot of Building Area	
Total Project Cost = Purchase Price + Soft Costs + Demolition Cost + Project Management Cost				

* Average cost for residential demolition includes the cost of asbestos abatement and removal of one underground storage tank.
Note: The values highlighted in the preceding table may change over time as CMSWS monitors and evaluates this plan and its processes.

Property Acquisition and Structure Relocation

Construction Type	Acquisition Cost (Purchase Price + Soft Costs)		Foundation Type	Relocation Cost*	Project Management Cost
Frame	Residential	*Tax Value x Multiplier + $4100*	Crawlspace	$58 / Square Foot of Building Area	5%
			Basement	$67 / Square Foot of Building Area	
Frame with Masonry Veneer	Commercial	*Tax Value x Multiplier + $7000*	Crawlspace	$64 / Square Foot of Building Area	
			Basement	$74 / Square Foot of Building Area	
Total Project Cost = Acquisition Cost + Relocation Cost + Project Mgmt Cost					

* Relocation cost includes detaching the home from its foundation, moving the home, building a new foundation at the new site, installing the home on the new foundation, and hooking up all utilities. The costs shown are based on the assumption that the home will be moved less than 5 miles and installed on the same type of foundation it had at its original location. Includes cost to restore old site ($12/square foot) but not the cost of any new property that must be purchased. Source: FEMA P-312, Second Edition / December 2009.
Note: The values highlighted in the preceding table may change over time as CMSWS monitors and evaluates this plan and its processes.

Property Acquisition, Demolition or Relocation, and Resale			
Acquisition Cost (Purchase Price + Soft Costs)		**Demolition Cost***	**Resale Earnings**
Residential	*Tax Value x Multiplier + $4100*	$10 / Square Foot of Building Area	% of Assessed Land Value based on Re-Sale Area
Commercial	*Tax Value x Multiplier + $7000*	$6 / Square Foot of Building Area	
Total Project Cost = (Acquisition Costs + Demolition Cost) * 1.05 - Resale Earnings			

* Average cost for residential demolition includes the cost of asbestos testing and abatement and removal of one underground storage tank.
** Total project cost is based on the demolition of the structure. For relocation of structure, the project cost will need to be determined using the relocation cost
Note: The values highlighted in the preceding table may change over time as CMSWS monitors and evaluates this plan and its processes.

Structure Elevation	
Construction Type	**Total Project Cost***
Frame	$32 / Square Foot of Building Footprint
Frame w/ Masonry Veneer	$36 / Square Foot of Building Footprint
Masonry	$63 / Square Foot of Building Footprint

* Estimated costs are based on a crawlspace foundation and elevating the structure 4 feet on continuous foundation walls or open foundation. Source: FEMA P-312, Second Edition / December 2009.
Note: The values highlighted in the preceding table may change over time as CMSWS monitors and evaluates this plan and its processes.

Dry Floodproofing		
Floodproofing Height *	**Sealant and Drainage Line****	**Flood Shields, Check Valves, Sump and Sump Pump*****
3 Feet	$43 / Linear Foot of Building Footprint	$7,690
Total Project Cost * = Sealant and Drainage Line Costs + $7690***		

* Dry floodproofing is not an appropriate technique for flooding over 3 feet deep, and is not recommended for homes with frame walls or with basements.
** Estimated cost is based on using the asphalt sealant method ($12 / linear foot) plus a drainage line around the perimeter of the building $31 / linear foot). Source: FEMA P-312, Second Edition / December 2009.
*** Estimated cost is based on assumption of 20 linear feet of shields (average price between metal and wood flood shields - $246), one plumbing check valve ($1,060) and one sump and sump pump with battery backup ($1,710). Source: FEMA P-312, Second Edition / December 2009.
**** Total project costs do not include protecting any exterior utilities or service equipment such as air conditioning compressors or fuel storage tanks.
Note: The values highlighted in the preceding table may change over time as CMSWS monitors and evaluates this plan and its processes.

Wet Floodproofing		
Floodproofing Height*	**Foundation Type**	**Total Project Cost*****
4 Feet	Basement **	$12 / Square Foot of Building Footprint
	Crawlspace	$6 / Square Foot of Building Footprint

* Measured in feet above basement floor or Lowest Adjacent Grade.
** Assumes unfinished basement.
*** Source: FEMA P-312, Second Edition / December 2009.
Note: The values highlighted in the preceding table may change over time as CMSWS monitors and evaluates this plan and its processes.

Appendix G: Pilot Study Flood Risk Property Score Sample Spreadsheet

	FLOOD RISK SCORING	
	Impact-based Scoring	*Points*
N/A	Flooding above the lowest finished floor of a building	0
25-yr	Flooding of electrical and/or mechanical equipment	48
10-yr	Flood water is touching a portion of the building (CS, UF Basement)	100
25-yr	Property is completely surrounded by flood water	44
25-yr	Structure is completely surrounded by flood water	20
N/A	Structure is completely surrounded by flood water and is a critical facility	0
N/A	Structure is completely surrounded by flood water and is multi-family residential	0
N/A	Flood water touching building with structural damage as a result of cumulative flooding	0
10-yr	Flooding of SIGNIFICANT exterior property improvements	60
N/A	Flooding of MODERATE exterior property improvements	0
10-yr	Flooding around area where single-family residential vehicles are typically parked	60
2-yr	Flooding of any yard (any portion of parcel)	15
		347
	Location Based Scoring	
NO	Building located in high danger depth-velocity zone	0
YES	Building located in medium danger depth-velocity zone	451
NO	Building located near area impacted by frequent storm drainage overflows	0
YES	Building located in Community Encroachment Area	382
451	***Flood Risk Property Score***	
FFE	622.6	
LAG	619.8	
LME	620.6	
2-yr	618.1	
10-yr	620.4	
25-yr	620.8	
50-yr	621.2	
100-yr	621.4	
500-yr	622	
EC Desc	Brick	
Basement	0	
Desc Blgd	RES	
Desc Prop	Single-Fam	
Foundtn	Crawl Space	
Heated A	1408	
NetBldg$	92000	
Story Ht	1 Story	

Appendix H: Pilot Study Mitigation Recommendations Sample Spreadsheet

	Technique	Further Evaluation Needed (Minimum Criteria)	Effective	Highly Effective, Recommended
1	Property Acquisition and Structure Demolition	1. Structure is pre-FIRM OR Structure is post-FIRM and has finished floor elevation lower than the Flood Protection Elevation 2. Property has Risk Score ≥ 300 OR	1. Property is located adjacent to publicly owned land OR 2. Any part of the structure is located inside a water quality buffer OR 3. Property has Risk Score ≥ 300 OR	1. Property is located at potential water quality capital improvement site OR 2. Property is located in critical needs area of planned greenway, park, sanitary sewer line, or water line OR 3. Property has Risk Score ≥ 700 OR
2	Structure Demolition and Rebuild	1. Land area outside the Community Encroachment Area is large enough to accommodate 1.5x the footprint of the structure (to account for setbacks) AND 2. Structure is located outside the FEMA Floodway AND	1. Structure is not surrounded by water during the FEMA Base Flood AND 2. Commercial and Multi-family only: Parking area serving property is above the FEMA Base Flood Elevation AND	1. Building tax value is ≤$300,000 AND 2. Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line AND 3. Property is not located at a potential water quality capital improvement site AND
3	Property Acquisition and Structure Relocation	1. Structure is pre-FIRM OR Structure is post-FIRM and has finished floor elevation lower than the Flood Protection Elevation 2. Structure is a single story (no split levels or multi-story) AND 3. Structure foundation is not slab-on-grade AND 4. Structure does not have masonry walls (Ex. Concrete block, precast panel, stone, etc.) AND 5. Structure footprint is ≤2000 sf AND 6. Building tax value is ≥$300,000 AND 7. Property has Risk Score ≥ 300 OR	1. Property is located adjacent to publicly owned land OR 2. Any part of the structure is located inside a water quality buffer OR 3. Property has Risk Score ≥ 300 OR	1. Structure footprint is ≤2000 sf AND 2. Property is located in critical needs area of planned greenway, park, sanitary sewer line, or water line OR 3. Property is located at a potential water quality capital improvement site OR 4. Property has Risk Score ≥ 700 OR
4	Property Acquisition, Demolition or Relocation, and Re-sale	1. Structure is pre-FIRM OR Structure is post-FIRM and has finished floor elevation lower than the Flood Protection Elevation 2. Resale portion of property is ≥1 acre for commercial, industrial or retail zoned property or ≥4 acre for residential zoned property AND 3. Resale portion of the property is outside the Community Encroachment Area AND 4. Property has Risk Score ≥ 300 OR	1. Property is located adjacent to publicly owned land OR 2. Any part of the structure is located inside a water quality buffer OR 3. Structure is not surrounded by flood water during the FEMA Base Flood AND 4. Property has Risk Score ≥ 300 OR	1. Property is located in critical needs area of planned greenway, park, sanitary sewer line, or water line OR 2. Property is located at a potential water quality capital improvement site OR 3. Property has Risk Score ≥ 700 OR
5	Structure Elevation	1. Structure is not located in an area with high-velocity flows AND 2. Structure foundation is not slab-on-grade AND 3. Structure is not a split level AND 4. Structure does not have a basement AND 5. Elevation height is less than 9 ft. AND 6. Building tax value is ≥$300,000 AND	1. Any part of the structure is located in the Community Encroachment Area AND 2. Structure is not surrounded by storm water during a 100-year storm event AND 3. Commercial and Multi-family only: Parking area serving property is above the FEMA Base Flood Elevation AND 4. Structure is located outside any water quality buffer AND	1. Structure is located outside the FEMA Floodway AND 2. Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line OR 3. Property is not located at a potential water quality capital improvement site OR
6	Dry Floodproofing of Structures	1. Residential Pre-FIRM - Lowest Floor is not necessarily above the FPE Residential Post-FIRM - Lowest Floor is above the FPE OR Non-Residential Pre- and Post-FIRM 2. Top of foundation wall is ≤3 ft above adjacent grade AND 3. Flood depths are ≤3 ft AND 4. Structure does not have a basement AND 5. Structure has masonry or masonry veneer type walls (Ex. Brick, brick face, stone, etc.) AND 6. Structure is not located in an area with high-velocity flows AND	1. Structure is not surrounded by flood water during the FEMA Base Flood AND 2. Parking area serving the property is accessible during the FEMA Base Flood AND 3. Structure is located outside any water quality buffer AND 4. Structure is located outside the FEMA Floodway AND	1. Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line AND 2. Property is not located at a potential water quality capital improvement site AND
7	Wet Floodproofing of Structures	1. Structure foundation is not slab-on-grade AND 2. Structures does not have a finished basement AND 3. FEMA Base Flood Elevation is ≤3 ft above the Lowest Floor (basement) or Lowest Adjacent Grade (crawlspace) AND 4. Finished floor elevation is higher than FEMA Base Flood Elevation AND 5. Structure is not located in an area with high-velocity flows AND	1. Structure is located outside the FEMA Floodway AND 2. Structure is surrounded by flood water during the FEMA Base Flood AND 3. Commercial and Multi-family only: Parking area serving property is above the FEMA Base Flood Elevation AND 4. Structure is located outside any water quality buffer AND	1. Structure is located outside the Community Encroachment Area AND 2. Any part of the structure is within the 100-year floodplain AND 3. Mechanical and/or electrical equipment is located below the 100-year flood elevation AND 4. Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line AND 5. Property is not located at a potential water quality capital improvement site AND
8	Audible Flood Warning System for Individual Property		1. Property is located in the Community Floodplain AND 2. The Lowest Adjacent Grade to the structure is below the Community Base Flood Elevation AND	1. Any part of the structure is within a high-velocity zone OR 2. Any part of the structure is within the 10-year floodplain OR
11	Automated Flood Notifications			1. Property is located in the Community Floodplain.
12	Public Education			1. Property is located in the Community Floodplain.
13	Flood Insurance			1. Property is located in the Community Floodplain.
15	Protecting Service Equipment (HVAC, electrical, utilities, fuel)		1. Service equipment elevation is below the FEMA Base Flood Elevation	1. Finished floor elevation of main structure is above the FEMA Base Flood Elevation AND 2. Structure is located outside the FEMA Floodway AND
16	Partial Dry Floodproofing	1. Structure does not have a basement AND 2. Structure has masonry or masonry veneer type walls (Ex. Brick, brick face, stone, etc.) AND 3. Structure is not located in an area with high-velocity flows AND 4. Structure is located outside the FEMA floodway AND		
17	Partial Wet Floodproofing	1. Structure foundation is not slab-on-grade AND 2. Structures does not have a finished basement AND 3. Structure is not located in an area with high-velocity flows AND 4. Structure is located outside the FEMA floodway AND		
18	Levee/Wall/Berm for a Single Structure	1. Structure is located outside the Community Encroachment Area AND 2. Structure is not surrounded by flood water during the FEMA Base Flood AND 3. Structure is located outside any water quality buffer AND 4. Structure is not located in an area with high-velocity flows AND		

Appendix I: Pilot Study Flood Mitigation Property Score Sample Spreadsheet

451	***Flood Risk Property Score***	
	MITIGATION SCORING	
	Priority Factors	*Points*
NO	Life and human safety	0
LOW	Cost effectiveness (Benefit-Cost Ratio)	0
YES	Proximity to other mitigation projects	125
NO	Property added to flood zone	0
NA	Repetitive loss structure	0
NO	Property adjacent to publicly owned land *	0
NO	Property located on five-year planned greenway trail *	0
NO	Property located on five-year planned sanitary sewer route *	0
NO	Property intersects with water quality buffer *	0
NO	Property located in an Environmental Focus Area *	0
YES	Property covered by NFIP policy	30
NO	Historic preservation and cultural asset protection	0
NA	Other	0
155	***Flood Hazard Mitigation Score***	
1.03	***Mitigation Score Multiplier***	
464	**FLOOD MITIGATION PROPERTY SCORE**	
FFE	622.6	
LAG	619.8	
LME	620.6	
2-yr	618.1	
10-yr	620.4	
25-yr	620.8	
50-yr	621.2	
100-yr	621.4	
500-yr	622	
EC Desc	Brick	
Basement	0	
Desc Blgd	RES	
Desc Prop	Single-Fam	
Foundtn	Crawl Space	
Heated A	1408	
NetBldg$	92000	
Story Ht	1 Story	